The Kurdistan Oil Spill of March 16-17, 1979: Activities and Observations of the Bedford Institute of Oceanography Response Team

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Canadian Technical Report of

Hydrography and Ocean Sciences No. 35

February 1985

THE KURDISTAN OIL SPILL OF MARCH 16-17, 1979: ACTIVITIES AND OBSERVATIONS OF THE BEDFORD INSTITUTE OF OCEANOGRAPHY RESPONSE TEAM

by

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FRONTISPIECE

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(Photography by H. Wiele)

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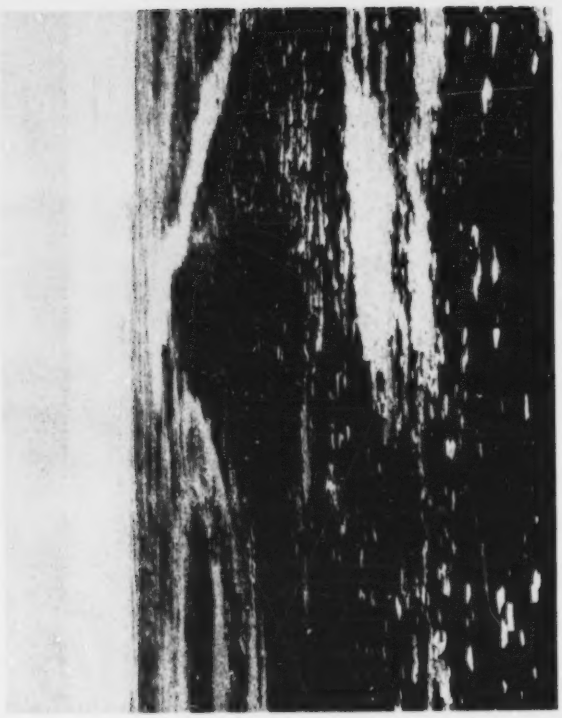

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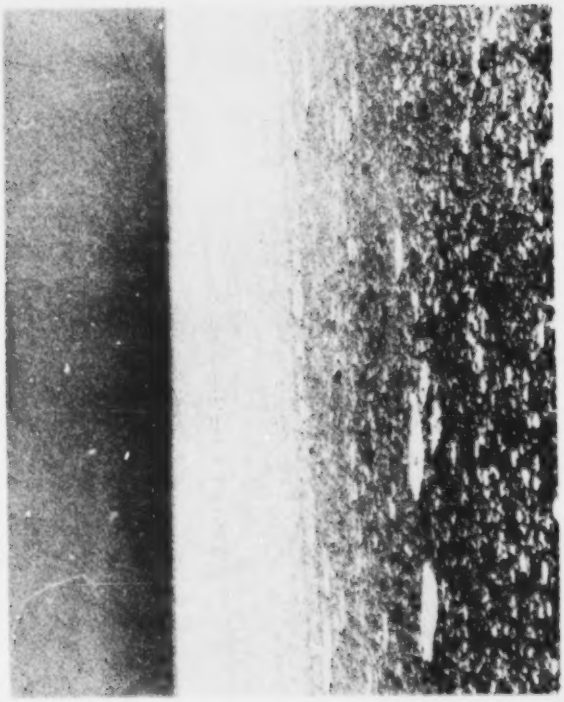

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(Photography by H. Wiele)

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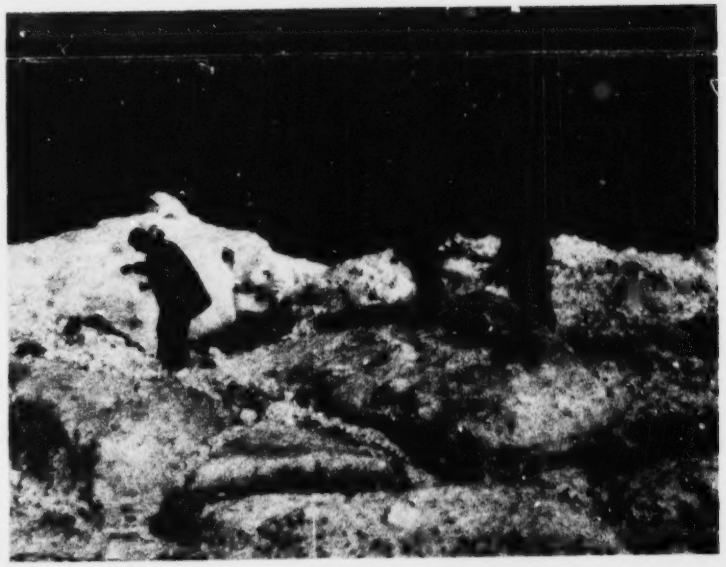
VI.

VII.



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ABSTRACT

Vandermeulen, J.H. and Buckley, D.E. (Editors). 1985. The KURDISTAN oil spill of March 16-17, 1979: Activities and observations of the Bedford Institute of Oceanography response team. Can. Tech. Rep. Hydrogr. Ocean Sci. 35: 190 p.

During the night of March 15 to 16, 1979, the tanker Kurdistan broke into two halves in the Cabot Strait, midway between Nova Scotia and Newfoundland, shortly after encountering heavy pack ice. During the break-up an estimated 7,000 tons of Bunker C fuel oil was spilled into the ice-infested waters of the Cabot Strait.

This report contains preliminary observations made by Bedford Institute of Oceanography (BIO) scientific personnel during the days following the tanker break-up, including initial observations on oil-in-ice at sea, stranding of oiled ice, mapping of the nearby Nova Scotia coastline, assessment of clean-up operations, and preliminary observations on seabird mortalities.

In addition the report includes three appendices listing wind and sea-state data for the spill period, spilled oil sighting reports, and a chronology of events surrounding the incident.

RESUME

Vandermeulen, J.H. and Buckley, D.E. (Editors). 1985. The KURDISTAN oil spill of March 16-17, 1979: Activities and observations of the Bedford Institute of Oceanography response team. Can. Tech. Rep. Hydrogr. Ocean Sci. 35: 190 p.

Pendant la nuit du 15 au 16 mars 1979 le pétrolier Kurdistan s'est brisé en deux dans le détroit de Cabot, à mi-chemin entre la Nouvelle-Ecosse et Terre-Neuve peu après avoir touché des icebergs. Durant cet accident, environ 7,000 tonnes d'huile Bunker C se sont répandues dans les eaux glacées de ce detroit.

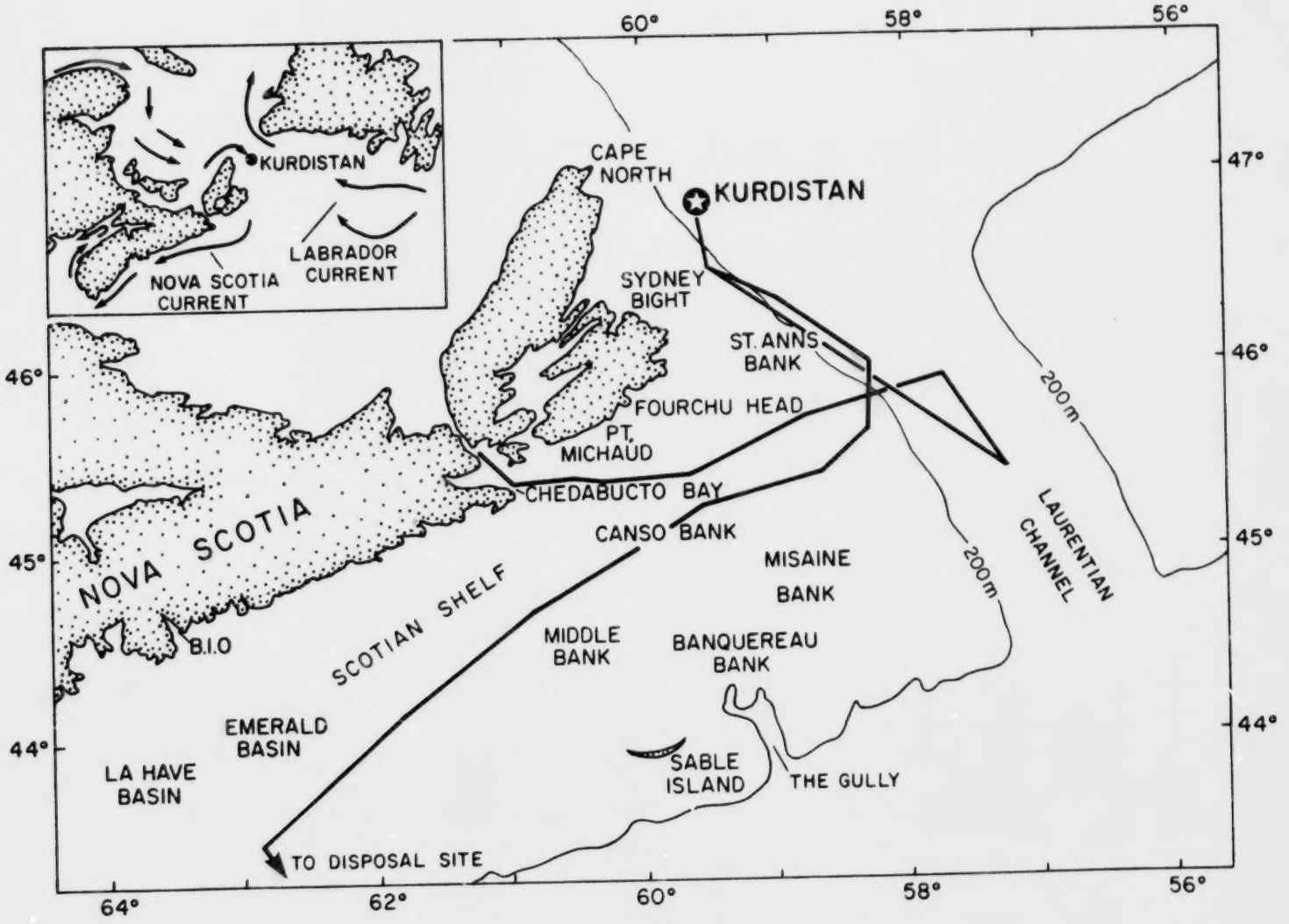
Ce rapport comprend les premiers observations faites par le personnel scientifique de l'Institut Océanographique de Bedford, et ce durant les jours qui ont suivi la catastrophe du pétrolier. Il inclut également les observations préliminaires concernant l'impregnation de l'huile dans la glace recouvrant les côtes proches de la Nouvelle-Ecosse, l'évaluation des opérations de nettoyage et les observations préliminaires sur la mortalité des oiseaux de mer.

En supplément, le rapport inclut trois appendices, la condition des vents et de la mer pour la période de fuite de l'huile, de rapports sur l'étendue de l'huile et une chronologie des évenements entourant cet incident.

ACKNOWLEDGEMENTS

We express our appreciation for support received from the Canadian Coast Guard (Dartmouth) and the Environmental Protection Services of Canada (Halifax). We expressly thank M. Turner, G. Donaldson and Captain G. Williams of the CCG and E. Pessah, C. Duerden, R. MacDonald and J. Swiss of EPS for their assistance throughout operation Kurdistan and for their help in the preparation of various parts of this report.

Special thanks are due to C. Behan and S. Hiltz of our own institute for typing the various drafts of this report.



Location Chart

PREFACE

Tanker scenario

During the day of March 15, 1979, the British registry tanker Kurdistan encountered considerable pack ice while en route from Cape Breton Island, Nova Scotia to Sept Iles, Quebec. At some point that evening the crew noticed oil leaking from two cracks in her hull. Shortly after returning to open water she broke into two that night, March 15 to 16, 1979.

The two sections of the tanker, both still containing large amounts of the Bunker C cargo in the remaining intact cargo tanks, were subsequently placed under tow by the Canadian Coast Guard under what can be best described as awesome weather conditions. The degree of control of the tow, particularly of the bow section, was sometimes very limited. The weather at the time included gale force winds, minus zero Centigrade temperatures, poor visibility due to snow flurries, and waves in excess of four meter heights. Under these conditions the crew was safely removed from the stricken tanker, and the two tanker sections more-or-less drifted out of the Cabot Strait into the Laurentian Channel (viz. Appendix I). Winter storms persisted for several days throughout this period, causing great difficulty to the towing operations (viz. Appendix II). In fact for part of this period the tugs towing the bow section, which was floating more vertically, could do little more than simply maintain the tow-lines to the bow.

With improvement in the weather, and with an appropriate "open-weather window" the stern section, still containing her intact part of the cargo, was towed to Port Hawkesbury through Chedabucto Bay where her cargo was off-loaded. The bow section, lacking the necessary heating systems to maintain her oil cargo in liquid form and floating in a near vertical position, was ordered sunk. Two possible disposal sites had been identified, the first the mouth of the Laurentian Channel and the second south of Sable Island. She was finally towed across the Scotian Shelf, passing between the Nova Scotia mainland and Sable Island, and was eventually scuttled by gun-fire off the Scotia Shelf, south-east of Sable Island, in over 2,000 fathoms of water on April 1, 1979.

Fate of spilled oil

Sometime during the break-up of the tanker about 7,000 tons of Bunker C oil was spilled into the waters of Cabot Strait, which at that time were largely ice-covered. Within a few days after the break-up more pack-ice had moved down through Cabot Strait into the Sydney Bight area and completely covered the waters offshore from Cape Breton as far south as Chedabucto Bay. In the process, although some minor oil sightings were reported, the bulk of the spilled oil disappeared from view.

In fact, the bulk of the oil disappeared from view during the night of the tanker breakup (March 15/16), and even the first Coast Guard personnel on the scene of the accident the following morning were unable to report any sizable oil slicks. Part of the oil was later found entrapped in ice off the south-east coast of Cape Breton Island between Pt. Michaud and Gabarus Bay (viz. location chart), but the amount estimated was far short of the ca. 7,000 tons spilled.

Despite periodic reports of oil from various parts of the Scotian Shelf and from Nova Scotia shorelines, initially it had been thought that the bulk of the oil had drifted out to sea into the North Atlantic ocean. First inklings of a differing possibility arose with reports of oil slicks over the north-eastern portion of the Scotian Shelf, over the Banquereau and Misaine Banks, beginning April 1. On April 9 and 10 oil began to come ashore onto the south-east coast of Cape Breton Island, followed three days later (April 13) by heavy continuous oiling of the north shore, enveloping the Sydney Bight (Appendix III).

In the end shoreline oiling was reported as far south as Lunenburg County, on the south shore of Nova Scotia mainland, fully two and a half months after the Kurdistan breakup.

Bedford Institute of Oceanography activities

Immediately on learning of the tanker disaster the Bedford Institute of Oceanography mobilized a small group of scientists with experience in oil spill studies and representing a broad range of oceanographic disciplines. Their task was three-fold: to offer expert assistance and advice to the Canadian Coast Guard (lead-agency for the Kurdistan incident), to act as liaison between the emergency task force and the broad range of

oceanographic expertise and facilities of the Bedford Institute of Oceanography, and to coordinate any scientific studies or investigations that could be made. The Bedford Institute of Oceanography had been involved totally in the 1970 Arrow oil spill, and several of the scientific staff had been involved in other subsequent tanker and spill incidents, including the Golden Robin, the Irving Whale and more recently the Amoco Cadiz in France. The members of the designated BIO Response Team are listed below, together with their affiliation and area of interest:

Dr. R.G.B. Brown - Marine Birds/Mammals
Canadian Wildlife Service, BIO

Mr. D. Buckley - Environmental Marine Geology
Atlantic Geoscience Centre, G.S.C., BIO
Energy Mines & Resources

Dr. E.M. Levy - Chemical Oceanography
Atlantic Oceanographic Laboratory, BIO

Dr. H.A. Neu - Physical Oceanography
Atlantic Oceanographic Laboratory, BIO

and Dr. J.H. Vandermeulen, coordinator - Marine Pollution Studies
Marine Ecology Laboratory, BIO

From March 16 until April 2 the BIO response group met on an almost daily basis with other members of the inter-agency Regional Environmental Emergencies Team (REET), which comprised representatives from the Canadian Coast Guard (CCG), the Atmospheric Environment Services (AES), Fisheries (FM), Environmental Protection Service (EPS), and the Province of Nova Scotia. In this context the BIO response group acted primarily as the scientific arm of the REET group, providing expert oceanographic backup for the activities of the Coast Guard. It did not provide this directly to the Coast Guard, but indirectly through EPS, which acted as liaison between the Coast Guard and the REET.

The BIO response group also initiated a number of field studies, including assessment of potential drift trajectories and oil-in-ice interactions, the preliminary results of which are included in this report. It also initiated, in cooperation with C-CORE (Memorial University of Newfoundland) a scientific workshop to discuss findings and observations

made during the Kurdistan incident. Proceedings of that workshop are published separately in a later report*.

The activities of the BIO group broadened considerably when the spilled Kurdistan oil, which was initially lost from view, began to arrive in significant amounts on the shores of Cape Breton Island and mainland Nova Scotia. Further sampling programs and field studies were initiated, some of which were eventually grouped into a more formal Scotian Shelf Monitoring Program under the direction of Dr. C.S. Mason of the Atlantic Oceanographic Laboratory. The results of that monitoring program will be the subject of a later publication.

This report covers the activities of the B.I.O. Scientific Response Team, and includes scientific reports on some of the observations made by team scientists during the period March 15 to April 1 1979.

We appreciate that much of the reported material is preliminary, often lacking in-depth detail and follow-up observations. We have nonetheless included all observations because they were made at the time, and because they reflect direct observations, including a number of photographs, and thoughts immediately following this spill. Very little is known about the behavior of oil in ice, or indeed about the behavior of a stricken tanker or of tanker halves in ice-infested waters. For that reason all available information, however preliminary, becomes very necessary. For that same reason this report include three appendices - a chronology of events surrounding the Kurdistan incident (Appendix I), a table of wind and seastate data including cruise tracks of the two tanker halves for the period March 15 to April 13 (Appendix II), and a table of all available oil sighting reports for the period March 15 to May 31 (Appendix III). This data was extracted from various sources and included in this report so that it would be readily available in one place for anyone who at some later date wants to review certain aspects of this incident.

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* Kurdistan Scientific Studies: Proceedings of a Workshop. June 1979. Vandermeulen, J.H. ed. Bedford Institute of Oceanography Report Series, BI-R-80-3, 1980.

Too often in the case of past spills have the first observations and the photographic record become lost or become misplaced. We hope that this report to some extent preserves the record of the Kurdistan.

J.H. Vandermeulen

D. Buckley

I. BIO SPILL RESPONSE

J.H. Vandermeulen
Marine Ecology Laboratory
and
D.E. Buckley
Atlantic Geoscience Centre

During the initial days of the Kurdistan spill the response from B.I.O., as member of the interagency Regional Environmental Emergencies Team (REET), was primarily advisory. BIO staff provided information on slick and tanker drift trajectories, and on environmental sensitivities of coastal waters and shoreline ecosystems. This was provided, via EPS intermediates, to the Coast Guard On-Scene Commander (OSC). As time went by B.I.O. involvement became in part more direct, with in-the-field observations on some of the aspects of oiling, both at sea and on-shore. As well observations on some oil-in-ice features were initiated in response to questions that arose during discussions with the Canadian Coast Guard and the Environmental Protection Service. These various activities are outlined below.

ACTIVITIES

I. B.I.O. advisory to the OSC (Canadian Coast Guard)

Lead-agency during the Kurdistan operation was the Canadian Coast Guard. Beginning on Monday March 19 a series of nearly daily environmental advisory meetings were held either at EPS offices in Halifax, and later at CCG headquarters in Dartmouth. Participating in these meetings were representatives of the various federal and provincial organizations, forming the Regional Environmental Emergencies Team. These included the Atmospheric Enviroment Services, Fisheries Management, Environmental Protection Services plus the B.I.O. Response Team. Responsibility of the REET Group was

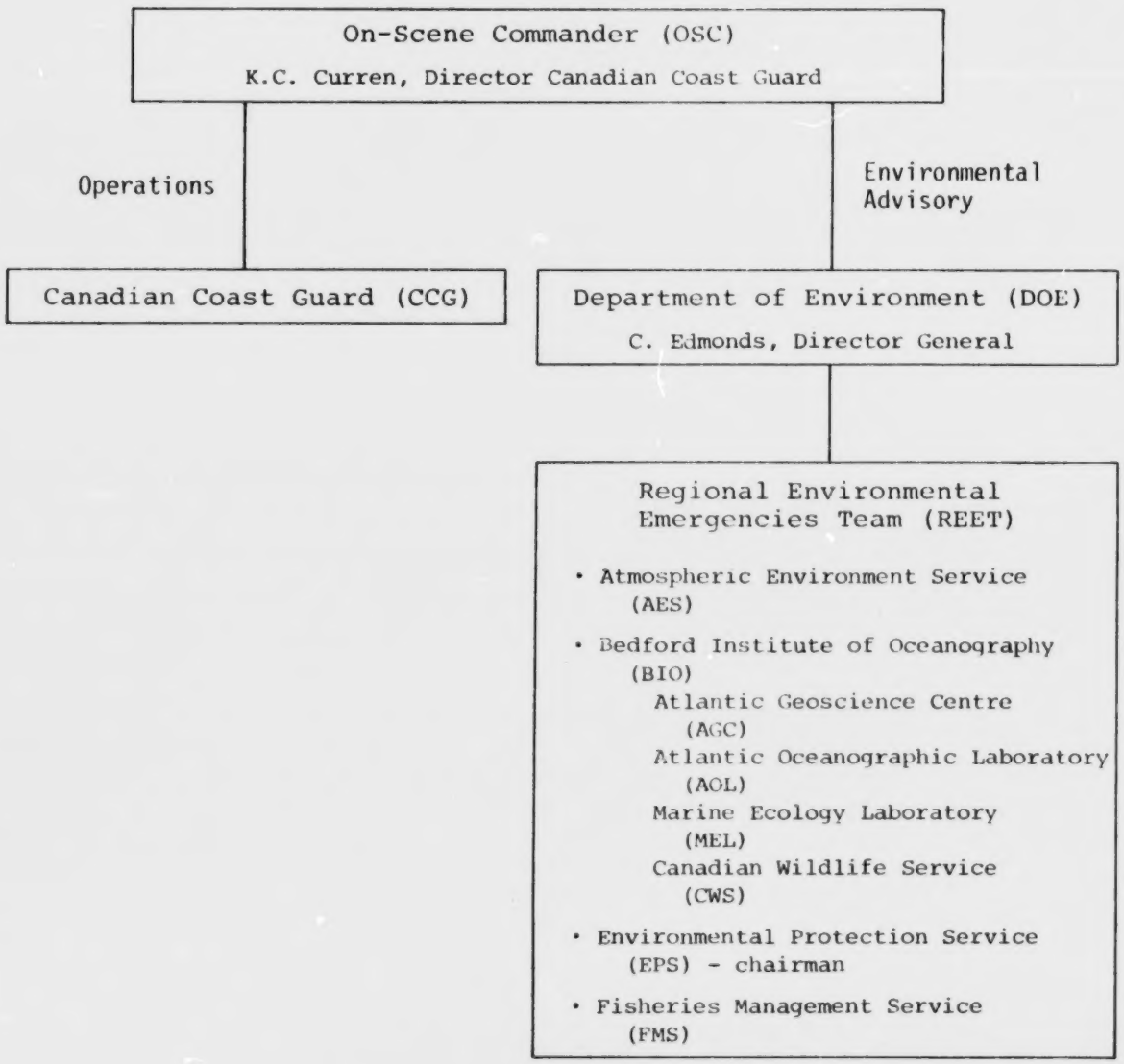
On-Scene Commander (OSC)
K.C. Curren, Director Canadian Coast Guard
Operations
Environmental Advisory
Canadian Coast Guard (CCG)
Department of Environment (DOE)
C. Edmonds, Director General
Regional Environmental Emergencies Team (REET)
• Atmospheric Environment Service (AES)
• Bedford Institute of Oceanography (BIO)
Atlantic Geoscience Centre (AGC)
Atlantic Oceanographic Laboratory (AOL)
Marine Ecology Laboratory (MEL)
Canadian Wildlife Service (CWS)
• Environmental Protection Service (EPS) - chairman
• Fisheries Management Service (FMS)

Figure 1. Organizational scheme linking various Canadian federal agencies that were involved in the Kurdistan operation.

to assess the daily weather, sea and ice conditions for the Cabot Strait and Scotian Shelf, provide environmental information and analyze drift trajectories for any slicks and for the two drifting tanker halves. The conclusions and recommendations of the REET group were then passed via the REET chairman to the OSC of the Kurdistan operation. (viz. figure 1).

The specific role of the BIO group in this was to provide expert scientific advice and opinion on matters relating to all areas, including commenting on salvage proposals, routing of the hull sections over fishing grounds, prediction of current drift patterns, analysis of towing characteristics with respect to effects of wind and currents, advising on suitable deepwater sinking (disposal) sites, etc.

Specific contributions by the BIO scientific group included the following:

- daily assessment of drift trajectories for the bow and stern sections.
- preparation of 24-hour and 48-hour drift predictions for hull sections and for possible slick movement in the event of either of the sections breaking up while en route over the Scotian Shelf.
- daily updated assessment and identification of environmental risk from any spills.
- daily advice to CCG on surface current patterns for the Scotian Shelf waters.
- identification and evaluation of sensitive ecological areas of the Scotian Shelf, as fishing grounds and marine bird colonies.
- scientific advice to CCG on the collection of legal cargo oil samples, and provision of collecting materials.
- environmental assessment of criteria for selection of emergency off-loading ports for the stern section.
- advice on and recommendation and review of proposed towing routes for bow and stern sections.
- assessment of and selection of designated offshore disposal/scuttling sites for hull sections.
- risk analysis of offshore and inshore spills resulting from accidents during towing operations.
- development of oil-drift trajectories for the Scotian Shelf.

II. Oceanographic and Oil-in-Ice Observations.

Immediately following the news of the tanker breakup BIO scientific staff participated in two fixed-wing overflights of the spill area to form first-hand impressions of seastate, slick movement, and behavior of oil in ice and on the sea surface. Dr. H.A. Neu (AOL) was a member of the first EPS-organized overflight on March 16 and made observations on wave action and effect on the movement of the two hull sections, which by this time were separated and drifting apart several miles in the Cabot Strait area. His observations were telephoned back from Cape Breton to B.I.O., and formed the basis for subsequent discussions with the Canadian Coast Guard and for an AGC sponsored overflight for March 17. At the time little oil was observed on the sea surface, and no oil was seen in the vicinity of the ice field. On the basis of existing surface current information and on observed wind data he further derived a projected oil slick trajectory resulting from the Kurdistan. These various observations and discussion are contained later in this report (Neu, pp. 33-38).

Later oil-in-ice observations were carried out separately by Drs. R. Trites and J.H. Vandermeulen (Marine Ecology Laboratory). First oil-in-ice observations were made on a helicopter overflight following reports of oil entrapped in ice offshore from south-east Cape Breton Island. The observations team included Dr. R. Trites, Dr. G. Reinson (AGC), Dr. A.R. Locke (CWS) and a fisheries representative. Subsequently Dr. R. Trites went aboard the CSS Hudson (see footnote) which had been requested to stand by in the vicinity of Chedabucto Bay, in preparation for possible chemical and other offshore work associated with this spill.

In preparation for the CSS Hudson participation laboratory support staff from the chemical oceanography division of AOL with field sampling gear was placed on standby in the Canso Strait area. Subsequently this technical staff with Dr. Trites as chief scientist were transported aboard the CSS Hudson by CCG helicopters, including all field sampling and chemical analytical equipment. The CSS Hudson was then deployed for a three

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The CSS Hudson was returning from a month-long fisheries survey cruise when she was requested to delay her return and standby in the Cape Breton region. Her crew and master had been aboard the CSS Hudson without leave for the duration of the survey cruise to that point.

day survey of oil-in-water reports originating from south-east Cape Breton. She also carried out a preliminary water-column sampling survey of Scotian Shelf waters offshore from southeast Cape Breton Island down to Halifax harbor. Cruise results and observations are contained in a later report by Dr. Trites in this volume (viz. Trites, pp. 39-56).

This first Hudson cruise formed the basis for later more comprehensive Scotian Shelf hydrocarbon monitoring cruises carried out by the Atlantic Oceanographic Laboratory in collaboration with the Canadian Coast Guard during the remaining months of 1979 and into 1980.

Further oil-in-ice observations were made on a helicopter assisted field trip by Dr. J.H. Vandermeulen, G. Harris (EPS) and H. Wiele (BIO staff photographer). The survey included both offshore observations on ice movement and oil distribution and a more detailed examination of oil movement and behavior in inshore waters, and of oil stranded onshore. Several samples were collected for later analysis. As well complete photographic documentation (both black and white and color photography) was carried out (viz. Vandermeulen, pp. 57-74).

III. Coastal Studies

Due to the proximity of the Kurdistan breakup to the Cape Breton shoreline and the real possibility of shoreline oiling all available information within BIO files concerning the nature of the shoreline of north and northeast Cape Breton Island was assembled and evaluated. This was in anticipation of a request for shoreline sensitivity evaluation from the Environmental Emergencies Coordinator of SPS, the agency with onshore responsibilities in the event of a spill.

Because of the paucity of shoreline data for this part of Cape Breton immediate arrangements were made for a BIO reconnaissance overflight on March 17, 24 hours after the spill. The reconnaissance flight included D.E. Buckley (Environmental Marine Geology), E.M. Levy (Chemical Oceanography), R.G.B. Brown (Canadian Wildlife Services) and R. Belanger (B.I.O. Photography). The flight path included a brief inspection of the Kurdistan breakup site, but focussed mainly on a detailed aerial photographic and visual survey of the eastern coastline of Cape Breton Island from Glace Bay to Lennox Passage. Observations, including periodic oblique photographs,

were subsequently included in an assessment of the geomorphological and sedimentological nature of this coastline. This, together with available existing information, was then assembled in the form of a preliminary coastal environmental sensitivity map for the section of the Cape Breton coast from Scatarie Island to Isle Madame, Chedabucto Bay. With time the preliminary sensitivity map was in turn further developed with information obtained from later field observations carried out by personnel from the Atlantic Geoscience Center at BIO (viz. Reinson, pp. 77-93).

BIO personnel also provided in-the-field scientific support to both the Coast Guard and EPS. For example, in anticipation of shoreline contamination and eventual cleanup, the EPS Environmental Emergencies team was transferred to the Canso Strait area. In order to provide more immediate advice to this team on coastal cleanup techiques and implications Dr. G. Reinson, R. Taylor and D. Frobel of AGC also went to the Canso Strait area. In addition they conducted further shoreline and aerial reconnaissance using flights of opportunity (viz. Taylor & Frobel, pp. 95-113).

IV. Sinking of Bow Section - BIO Involvement

Shortly after the breakup of the tanker Kurdistan it became clear that the bow section, lacking the necessary heating coils etc. to keep its cargo oil in fluid form, might have to be treated separately from the stern section. Accordingly, at the request of the OSC CCG, the BIO scientific team in direct cooperation with EPS and other members of the REET Group monitored the towing route and towing characteristics of the bow section and indicated two possible disposal sites. The first was located on the shelf break near the outflow of the St. Lawrence and served as disposal site A while the bow section was still traversing the north-eastern half of the Scotian Shelf.

An alternate deeper disposal site, designated as disposal site B, was selected south of Sable Island on the Scotian Shelf slope in 2,400 fathoms of water. The bow section was eventually towed to this site and was scuttled by gunfire. Dr. D. McKeown (BIO AOL) was on board the Canadian navy vessel Margaree and served as observer for BIO during the scuttling operation. He also arranged for a radiotransponder and other tracking gear to be placed aboard the bow section in an attempt to maintain contact with

the sunken bow section, and locate its final position. His observations of the scuttling operation and his comments are included later in this report (viz. McKeown, pp. 115-128).

V. Water Column Oiling Studies

As a result of concerns over possible oiling impact on inshore fisheries (lobster etc.) an inshore hydrocarbon sampling cruise was initiated, involving BIO scientific personnel (the chemical oceanographic division of AOL, the environmental quality research group of MEL and staff from the EPS laboratories at BIO) and the Fisheries Management research vessel J.L. Hart and crew.

The weeklong cruise sampled coastal water inshore of the 50 fathom line from Chedabucto Bay south to Halifax harbor. Analysis of water samples was performed at Bedford Institute under the scientific authority of Dr. E. Levy, AOL. A broader Scotian Shelf hydrocarbon monitoring program involving several research cruises including BIO vessels, Fisheries Management ships and Royal Canadian Navy ships was designed subsequently and is being coordinated by Dr. C.S. Mason, AOL.

VI. Slick Trajectory Work.

In response to CCG concerns over oil slicks which might originate from the scuttled bow site a number of slick trajectories were calculated by Dr. D. Lawrence, AOL, in collaboration with P. Galbraith of Atmospheric Environment Services and using existing and modified computer programs. Using a specially developed wind-data file (multi-point winds) it was shown that likelihood of such slicks reaching the Nova Scotia mainland or its inshore waters was extremely remote.

Similar trajectories were calculated for prediction of oilslick movement after increasing numbers reports of surface oil over the Missine and Banquereau Banks beginning about April 1. These trajectories formed the basis for evaluation of slick movement and counter-measure discussions.

This part of the BIO involvement was also subsequently developed into a broader surface current study program, within AOL, under the overall supervision of C.S. Mason.

VII. Impact on biota.

During the initial days, observations on oiling impact on marine biota were restricted to observations on seabirds. These were initiated by Dr. R.G. Brown of the Canadian Wildlife Service Seabird Research group at BIO (viz. Brown, p. 129), and were subsequently taken over by the CWS headquarters group at Sackville, N.B.

Because of the disappearance of the Kurdistan's spilled cargo observations on marine biota (phyto or zooplankton, macroinvertebrates, fish) became problematical. Therefore most of the emphasis was placed on immediate observations on oil-ice interaction where possible.

VIII. BIO Scientific Staff Involvement.

Atlantic Oceanographic Laboratory (AOL)

G.T. Needler - discussion/consultation

M. Bewers - discussion

E.M. Levy - discussion/consultation, laboratory analysis

C.C. Cunningham - field sampling, chemical analysis

J. Moffat - field sampling, chemical analysis

C.S. Mason - discussion, cruise coordination

D.S. Bezanson - discussion

D.J. Lawrence - slick trajectory consultation

H.J.A. Neu - member, BIO scientific response team.

D.L. McKeown - observer, scuttling of bow section.

J.A. Elliott - discussion.

D. Conrad - field sampling, chemical analysis.

Marine Ecology Laboratory (MEL)

A.R. Longhurst - discussion.

J.H. Vandermeulen - coordinator, BIO scientific response team.

T.P. Ahern - chemical analysis.

B. Amero - field sampling, chemical analysis.

D.M. Ware - discussion.

R. Trites - field observations.

Atlantic Geoscience Centre (AGC)

C.E. Keen - discussion

D.E. Buckley - member, BIO scientific response team.

D. Frobel - field work.

G.E. Reinson - field work, advisor to EPS.

R. Taylor - field work.

Wang Ying - laboratory support

Institute Facilities:

R.L. Gilbert - ship facilities

C.E. Murray - press relations

H.B. Nicholls - discussion

R. Belanger - field photography

H. Wiele - field photography

Canadian Wilflife Service (CWS)

R. Brown - member B.I.O. scientific response team

Environmental Protection Service (EPS)

G. Pelly - field sampling

Fisheries Management Service (FMS)

R. O'Boyle - discussion

CONCLUSIONS AND COMMENTS

1. It seems obvious, both at the time of the spill and at this time of writing, that the BIO Scientific Response group served an extremely useful function in providing appropriate and generally accurate scientific and technical advice and support to the OSC through the EPS coordinator.

In future, however, it would be more advantageous to both the OSC and to the BIO scientific advisors if closer more direct communications were established between the On Scene Commander and the

scientific facilities at B.I.O.

2. There were several gaps in the data base that to various extents hindered predictive or interpretative capability when called on to provide instant advice, assessment or opinions. These included absence of information on Scotian Shelf surface currents, and on the geomorphology of the Cape Breton coastline. There was a very obvious lack of information on behavior of oil in ice or in ice-infested waters.

The immediate data gathering and reconnaissance overflights by AGC in part resolved the coastline oiling problems associated with shoreline sensitivity. However, this also pointed out that the same problem, only several orders of magnitude larger, exists with the south coast of Newfoundland for which little or no coastal geomorphological data exist.

The present on-going Scotian Shelf surface current studies are in direct response to that identified gap in the data base and should do much to assist in future problems.

A workshop on the Kurdistan oilspill, particularly vis-a-vis its oil-in-ice aspects, was organized for the exchange of observations on oil-in-ice behavior and to further develop a data base in this area (viz. Vandermeulen, 1980).

3. A major difficulty in coping with this incident was the lack of reliable and consistent reports of oil at sea. At times when slicks were reported, they could not be later confirmed by subsequent observations, either from aircraft or from specially designated surface vessels.

It is recommended that a standardized oil-sightings file be established and maintained, particularly during a spill incident. This file should contain not only reports of sighted oil, but should also contain continuous reports from other parts of the entire Scotian Shelf area, including reports of no-oiling. The latter would help in defining extent of oiling over the Shelf area.

Where possible all oiling reports should be followed up by radio or radio/telephone to the vessel master for further detailed

description of the oil sighted. This detailed oiling information should be in a form useful for later scientific follow-up and analysis.

4. This was Canada's first oil-in-ice spill, and while it is still in question whether the bulk of the oil travelled within the ice, or came free of the ice-fields of Cabot Strait and drifted freely over the Scotian Shelf, nonetheless a good deal has been learned of the behavior of oil in these ice-infested waters.

The most vexing problem underlying the whole Kurdistan operation, however, was the disappearance of the 7,000 tons of oil spilled, and its month later re-appearance and heavy oiling of Cape Breton.

It is strongly recommended that in future incidents all effort be directed at locating and monitoring the movement of spilled oil. This will involve both much more overflight time, as well as other means of detection as by remote sensing. More overflights and photo-documentation of the various features of oil in ice must be included in any future planning and response, if we are to develop any capability of spill monitoring and impact prediction in both maritime and arctic waters.

5. Appropriate mechanisms must be set up so that opportunity exists for scientific studies at the time of a spill. There exist in each and every oil spill real opportunities for scientific study that are not afforded in the laboratory or in simulated field trials. However, there exist two problems. Such studies require instant financial support, and require direct co-operation of all the other organizations involved in the spill response effort.

In this respect it should be noted that proper spill countermeasure response is ultimately based on thorough scientific understanding and study, and that spill impact in the marine environment is totally dependent on appropriate scientific knowledge of spill behavior.

II. Oceanographic and Oil-in-Ice Observations

1. ASSESSMENT OF TANKER AND SLICK DRIFT FOLLOWING BREAK-UP OF THE TANKER "KURDISTAN"

H.A. Neu
Atlantic Oceanographic Laboratory

An overflight of the site of the KURDISTAN break-up and of the surrounding Cabot Strait provided an opportunity to assess the sea-state immediately after the accident, and if possible to make some first-hand observations on oil sighting and oil drift in or near ice.

The overflight was arranged by the Environmental Protection Service (EPS), using a fixed-wing four-passenger aircraft. The flight departed from Halifax at 1300 hrs. (local time), covered most of the Cabot Strait-Sydney Bight area, and returned to Sydney airport in Cape Breton about 1630 hrs. (local time).

Sea State

Most of the Sydney Bight area was open water, with the ice edge of the Cabot Strait ice-field some 10 to 12 miles offshore from Sydney. By the time we arrived over the broken tanker, the stern section was already under tow, 14 hours after the breakup during the night of March 15 to 16. The engine of the stern section appeared to be still under steam with smoke streaming from her funnel. Whether this indicated that the propulsion system was still functioning or that only the cargo heating system was operative was not clear, but it raised the possibility that with proper sea-going tugs the stern might have been pumped out if it could have been towed into a sheltered area. Additional sea-going tugs would have been required for this operation. On the other hand unloading at sea appeared impractical with a swell of 2 to 4 meters and periods of about 10 seconds.

The stern section was floating at an angle of less than 30° while the bow section was at an angle of more than 60° to the sea surface (Plates 1, 2). Waves were rushing up and down the decks of the two parts of the vessel. Air traffic control over the site, because of the large numbers of aircraft in the area, prevented us from performing a closer inspection of the two parts of the tanker.

Oil detection from the air

Aerial detection of oil at sea poses many problems, and is largely dependent on the appearance of the oil, its position on or in the sea surface, and on the sea-state. Except for a streak of sheen oil in the wake of the stern section, and later some sheen oil near the ice-edge we saw no massive oil slicks or any amount of oil that might correspond to the lost 7,000 tons of Bunker spilled from the tanker during the previous night. In total we may have seen 5 to 10 tons, but certainly not more than that. However, there may well have been more oil on the sea-surface that went undetected.

The problem is that both, water as well as oil, appear black from the air between the snow-covered ice sheets. This is particularly so if no waves or ripples are present on the surface. It was therefore impossible to say whether the liquid in the leads was oil or water. Therefore, there may have been quite an amount of oil in the ice-field that went un-noticed. The existence of this oil could only have been checked out with an helicopter or by some other means.

In addition, there are the problems with subjective interpretation of what one sees depending on several factors - the viewing angle, the airplane's angle of approach, the position of the sun, the angle of the sun rays and cloudiness. We had observed this same problem during the Arrow accident in Chedabucto Bay in 1970, which occurred at approximately the same time of year (February) with the same type of oil (Bunker C). In that case we learned that often several passes by the aircraft were required before a slick could be accurately located and its extent on the sea surface could be defined.

Sea state also affects visual detection of the oil. The only time we did see oil away from the stern section was near the ice edge toward the open water where, with waves present, oil irridescence became visible at a few locations.

We criss-crossed the ice field toward Newfoundland and examined the longer leads between the flows but we saw no evidence of any oil. This, as stated before, is not to say that there may not have been any oil present. We simply did not see any. There was also no oil, either in larger amounts or in spatters on the surface of the ice.

Finally, the flight clearly demonstrated that a successful search for oil slicks from the air in these waters at this time of the year requires both more time and considerable experience even from a helicopter where closer observation is possible. Better yet, other means of detection are needed that do not rely on weather, light incidence angles and height of viewing, presence of waves, etc. Remote sensing techniques can probably provide solutions to these problems, and should be investigated.

Hull and Slick Drift - Assessment

The two halves of the tanker and the oil slick probably may behave quite differently in their drift pattern, being dominated by different factors. While the tanker sections are more influenced by the integrated currents of the water column in which the hulls of the vessel float, the oil follows a more wind-dominated trajectory. However, the bow section may in addition have a wind-induced component in its drift pattern because of its near-vertical floating angle with the deck acting as a sail.

In general, after removing tide and meteorological effects, the residual movement of the surface layer through Cabot Strait is inward into the Gulf of St. Lawrence along the Newfoundland side and outward along the Cape Breton side. The outward-going current velocity is several times larger than the inward-going one. After leaving Cabot Strait it splits into a main current along the Laurentian Channel and a smaller flow around Scatarie Island forming the Scotian Shelf current and the local eddy in-shore near Gabarus (Figure 1). If forced by current drift only, the two sections of the tanker would probably move with this current in a south-westerly direction parallel to the coast of Nova Scotia.

The oil-slick, which is largely wind-dominated, will probably travel with the wind, which at the time of breakup is from the north and northwest, and should move along the Laurentian Channel out into the open Atlantic, by-passing the Scotian Shelf. However, some of the oil close enough in-shore may drift with the Scotian Shelf current, heading toward Chedabucto Bay. If winds change during the next few days to a week, the movement of the oil becomes more unpredictable. These trajectories are indicated in Figure 1.

Sinking of Tanker Sections in Cabot Strait - Assessment

If either of the tanker sections were to sink, the consequences could be different from the surface scenarios described above. The currents in the deep layer of Cabot Strait and Laurentian Channel are not outward directed as in the surface layer, but are inward directed into the Gulf of St. Lawrence. Thus: if the oil were to remain in the deep layers, it would probably be transported into the Gulf of St. Lawrence. If it ascends into the upper layer it would move with the surface layer which is wind-affected.

Efforts should probably be focused therefore on preventing an accident to the hull sections while in the Laurentian Channel or Cabot Strait that might result in their sinking, and in the possibility of later release of oil via the bottom currents into the St. Lawrence system.

SUMMARY

1. No large oil slicks were seen in the Sydney Bight area, either in open water or in the ice fields, on March 16, approximately 14 hours after the tanker breakup.
2. Aerial observation of oil-at-sea from fixed wing aircraft presents many problems, and is highly subject to subjective interpretation of visual observations.
3. Sea-state in the area was rough, with a swell of 2 to 4 meters and periods of about 10 seconds. This precluded any at-sea off-loading of the cargo.
4. Drift of spilled oil and of the tanker halves is subject to two different forces. While the spilled oil is largely wind-dominated, the drift of the tanker halves will be largely current-dominated. The drift of the bow section, however, will have a wind-component, due to its floating at a high angle with a large part of the deck projecting above the sea surface.
5. It is likely that the spilled oil, under the influence of strong north-westerly winds, will follow the Laurentian Channel toward the Atlantic Ocean. Oil found closer inshore may well follow the Scotian current, and move close inshore over the Scotian Shelf, along the east coast of Cape Breton Island toward Chedabucto Bay.

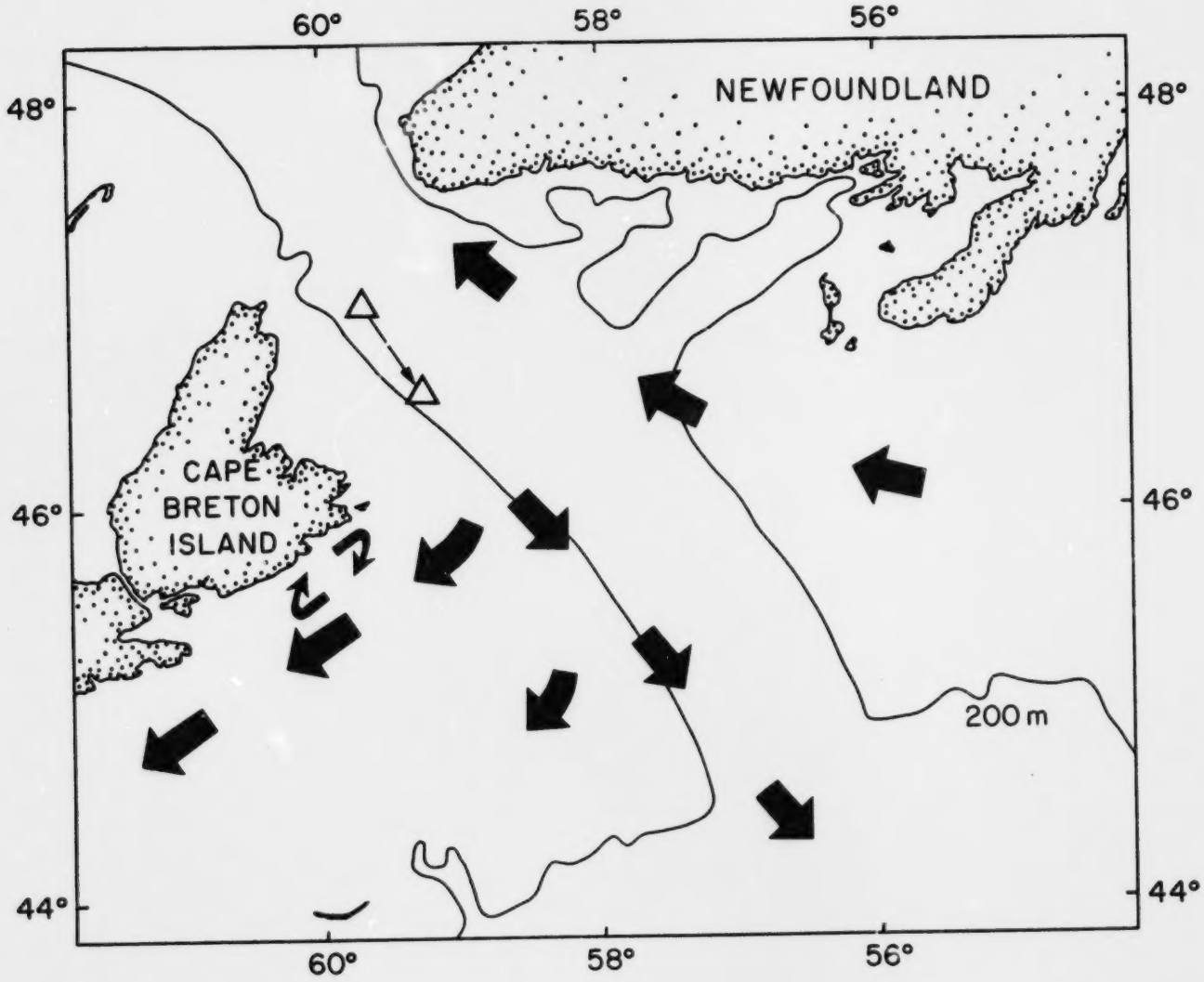
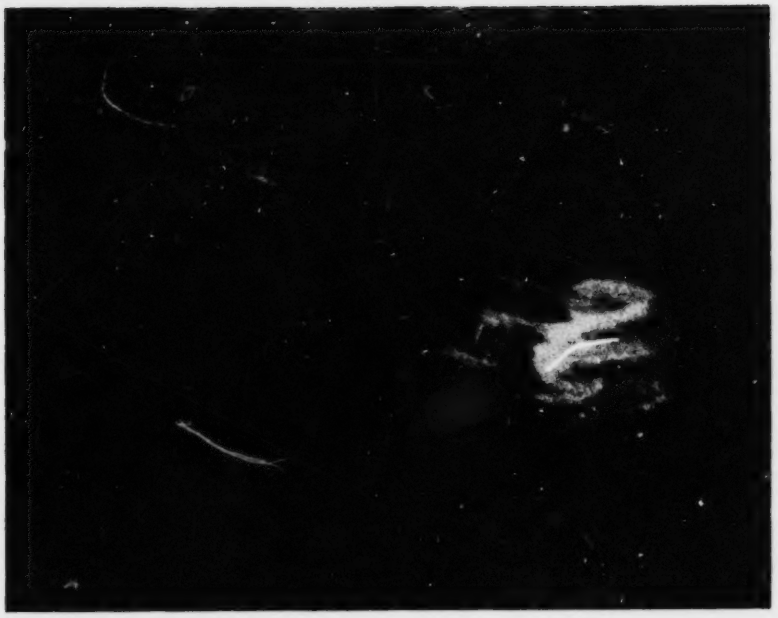
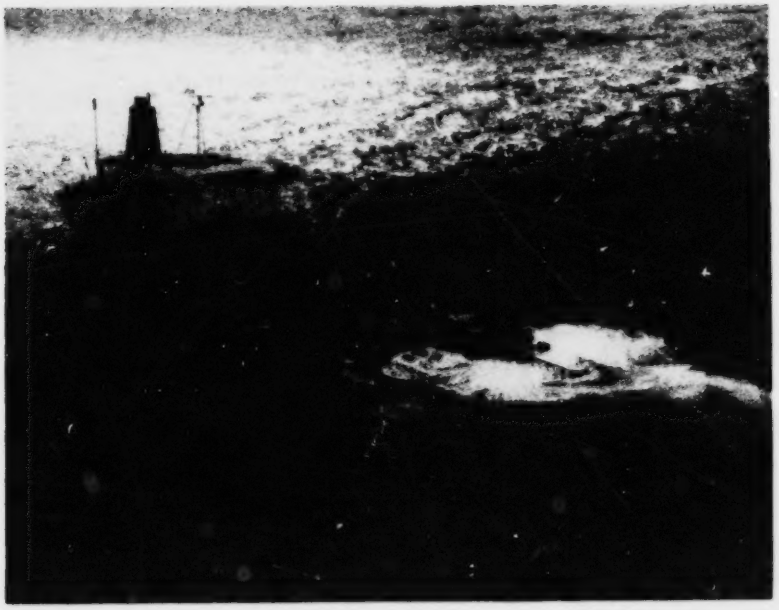


Figure 1. Projected slick trajectories for tne Sydney Bight and Scotian Scotian Shelf, resulting from tne KURDISTAN breakup.



(R. Belanger, BIO)

Plate 1. Kurdistan bow section adrift in Cabot Strait, March 17 1979.



(R. Belanger, BIO)

Plate 2. Kurdistan stern section , March 17 1979.

2. PRELIMINARY OBSERVATIONS ON OIL/ICE INTERACTION FROM CSS HUDSON

R.W. Trites
Marine Ecology Laboratory

INTRODUCTION

On March 15, 1979 the oil tanker Kurdistan broke into two halves in Cabot Strait. She was carrying Bunker C Oil, and an estimated 7,000 tons of oil escaped. On March 22nd a large area of oil-stained ice was reported and photo-documented by the Department of National Defence inshore along the south coast of Cape Breton Island (e.g. 45°40'N 60°13'W, and 45°38'N 60°21'W).

The following are the reports of a helicopter reconnaissance flight and of a subsequent CSS Hudson visit to the area. These were arranged by the Bedford Institute of Oceanography for the purpose of:

- acquiring samples of the oil and oil-ice mixtures
- carrying out vertical sampling of the water column in those areas where oil was present at the surface
- carrying out neuston net tows in open water to determine the amount and extent of oil present at the surface
- making observations on oil-ice interaction
- acquisition of a photographic record of the oil and oil-ice mixtures
- determining desirability and feasibility of carrying out special research experiments related to the Kurdistan oil spill and to oil-ice mixtures.

OBSERVATIONS

I. Helicopter overflight

A helicopter reconnaissance flight was arranged for March 23rd. The observational team consisted of:

R.W. Trites (MEL)
A.R. Lock (CWS)
A. McKinnon (Fisheries Management)

G. Reinson (AGC)

The flight lasted for about 1 1/2 hours and focussed principally on the area between Petit de Grat Island, Chedabucto Bay, and Fourchu Head on the east coast of Cape Breton.

A large stained ice streak, presumably the area reported by the Department of National Defence, was found within a few kilometres of Pt. Michaud. The streak appeared to be an oil-ice mixture, and extended to about 4 or 5 kilometers in a north-easterly direction, parallelling the coastline, and varied in width from about 20 to 200 meters. Occasionally small black patches (1 m diameter) were spotted to the northeast of the large stained area between Pt. Michaud and Fourchu Head.

Stained ice of roughly similar appearance to that referred to above was seen in numerous smaller streaks to the west of Fourchu Head, and generally within a few hundred meters from shore. Subsequent attempts to ground-truth these streaks indicated that they were probably mostly ice-sediment stains, rather than ice-oil stains.

II. CSS Hudson cruise

The following excerpt is taken from the ship's master's cruise logbook.

Cruise Report Number:	79-001-C
Vessel:	CSS Hudson (Plate 1)
Dates:	23-26 March 1979
Responsible Agency:	Marine Ecology Laboratory Bedford Institute of Oceanography
Area:	Inshore area, south of Cape Breton Island
Ships Master:	Capt. Strum
Senior Scientist:	R.W. Trites (Marine Ecology Laboratory)
Personnel:	James Abriel (Atlantic Oceanographic Lab.)
	Carl Cunningham (Atlantic Oceanographic Lab.)
	Frank Zemlyak (Atlantic Oceanographic Lab.)
	Vaughn Barrie (C-Core, Memorial University, Nfld., 25 March)

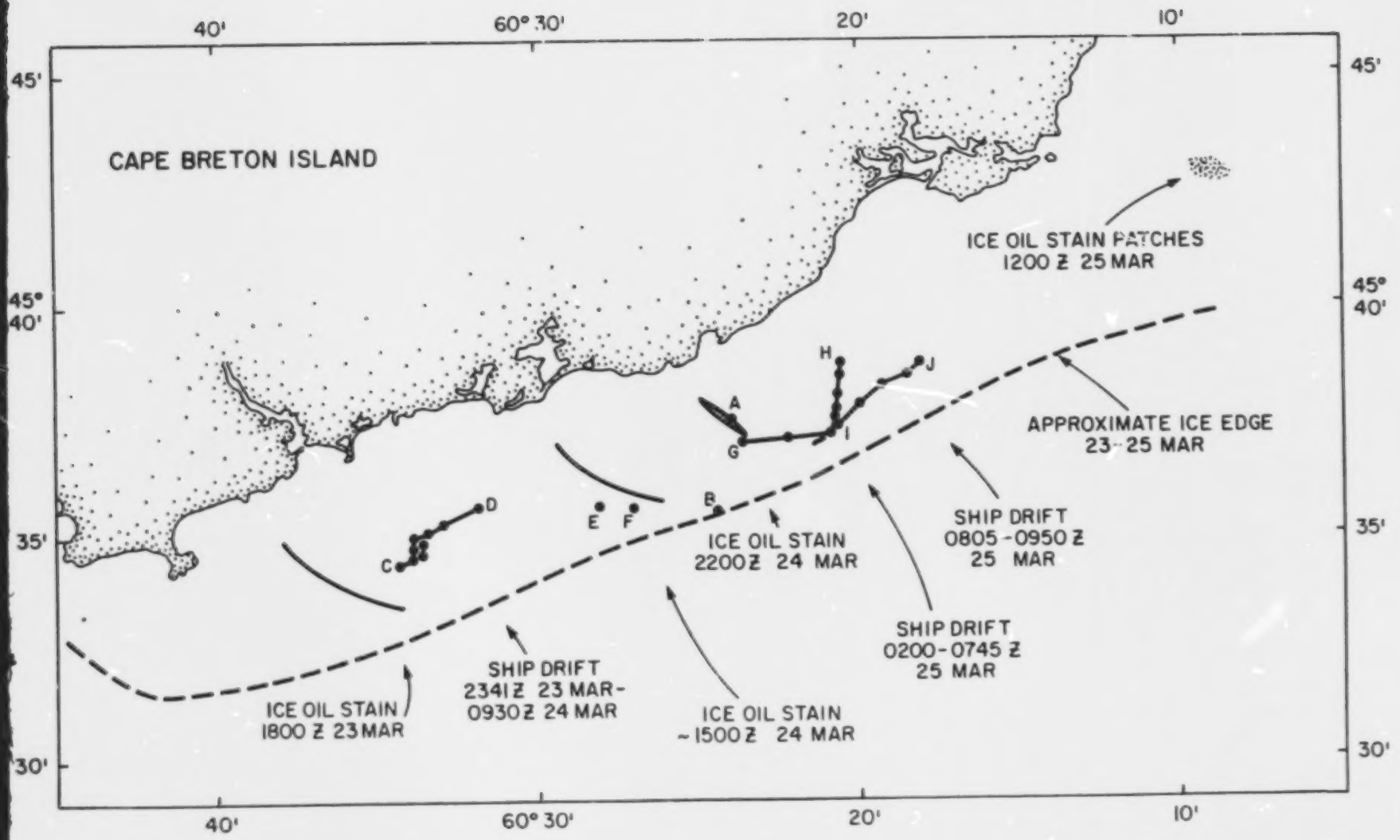


Figure 1. Chart showing location and movement of largest ice-oil stain seen during the period March 23-25 1979. Locations of oil and ice-oil and ice-sediment samples are shown (A,B,E and F) as well as the track of ship drift in ice (C-D, G-H and I, J).

23 March, 2000Z	At 2000Z at $45^0$35.38'N, $60^0$24.45'W piece of ice with oil on it of approximate dimensions 1' x 4' x 1' was observed. An oil sample was taken and placed in 2 mason jars (sample #3), and a 5-10 lb portion placed in a garbage sac (site B, Fig.1). Other samples were taken in the immediate area: Sample #1 surface water sample near oil, Sample #2 - 2 jars of ice-sediment mixture (Site A, Fig. 1).
2230Z	At about 2230 hrs. Dr. R.W. Trites joined the Hudson (by CCG helicopter) which was in ice, a short distance west of Pt. Michaud. Earlier in the day the Hudson had taken samples of the oil which was present in the ice in the vicinity of Pt. Michaud. The ship steamed to the area where the stained patch was seen from the helicopter flight and stopped and drifted near the oil-ice mixture overnight.
24 March 1230-1330Z	Lifeboat used to move into oil-ice mixture and take pictures and samples (slide 2). Ice cover (10/10) consists of a spectrum of sizes, including slush, brash, blocks, etc. with the largest pans being about 20-25M in diameter. Thickness varies but seems to be mostly 0.5-1M (Slide 3,4,5). Nine samples taken from lifeboat consisting of oil blobs, ice-oil mixtures, blocks of ice, ice-sediment mixtures and one sample that may be ice-algae. Position: 45°35.8'N, 60°26.2'W (sites E, Fig. 1).
1430Z	Commenced to run towards Isle St. Esprit, along an oil streak with an average width of about 100M. Northwest end of streak 45°36.5'N, $60^0$28.8'W. Length of oil streak about 5 Km.

1645Z	Owing to fog, ship is running into Chedabucto Bay, where weather is clear, in order that scientific personnel and equipment can be put on board by helicopter.
1900Z	Helicopter arrives (Memorial University, Newfoundland)
1915Z	CCG helicopter arrives with BIO AOL chemistry personnel and equipment
2130	Station 1, in ice-oil stain.
2213	Station 2, in ice-oil stain.
2244	Station 3, in ice
2332	Station 4, in open water at edge of ice
25 March 0038	Station 5, in open water
0200-0745	Ship drifting with ice
0805-0950	Ship drifting with ice
25 March 1052	
26 March 1400	Stations 6-21 occupied as shown in Fig. 1
26 March 2020	Arrived at BIO

Data acquired:

(1) Samples of "pure" oil.

(2) Ice-oil mixtures sampled from the lifeboat.

(3) Surface and subsurface sampling of the water column at 19 stations (slide 6).

(4) Neuston, oil tows at 14 stations (slide 7).

(5) Approximately 60 colour slides, 9 black and white and 10 Kodacolor pictures.

(6) Approximately 18 hrs of ice drift observations.

PRELIMINARY COMMENTS

1. Ice-staining observations

From the initial helicopter flight on 23 March it was difficult to be certain which stains were oil-ice mixtures, and which were sediment-ice or algae-ice mixtures. Our initial appraisal was that there was oil-stained ice both in the nearshore region as well as further offshore.

Subsequent ground truthing in fact revealed that the nearshore staining was due almost entirely to sediment ice mixtures. The large oil-in-ice streak, however, was ground truthed with Hudson in the early evening of March 23rdl and consisted indeed of oil in ice.

Upon closer examination of the ice-oil mixture it seemed to be composed largely of discrete lumps (slide 8), blobs (slide 9,10), specks etc. of oil. There was a wide spectrum of "particle" sizes - ranging from smaller than sand grain size to about 1m in diameter. Most of the staining impression was actually actually found to be due to the "speckling" of the sand-grain sized to gravel-sized pieces of oil embedded in the ice-surface (slide 11,12,13). One had to be careful, however, in not mistaking either sediment staining or what appeared to be algal inclusions for oil staining (slide 14,15). This distinction could only be made after considerable experience, or was best done by close inspection as from a life-boat.

II. Oil in and under ice

An attempt was made from the CSS Hudson to determine whether there was oil under the ice in areas where no staining was visible on the surface of the ice. In several cases there appeared to be oil underneath the ice, but these invariably proved to be false impressions caused by dark melt-holes in the ice under the sea surface (slide 12). Further observations made on ice blocks that were overturned by the ship passing through it proved equally negative. Although we were unable to observe many overturned pieces, mainly because the ship tended to move them sideways rather than overturn them, those we did observe seldom had any visible oil on the underside. From these various observations we concluded that there probably wasn't any large quantity of oil extending underneath the ice inshore of the east coast of Cape Breton. With respect to sampling of floating oil stations were laid out so as to gain a rough idea of the geographic extent of the oil floating within the ice field. It appeared to be confined to an area not larger than about 20 x 100Km. The amount of oil per tow was estimated to about 15cc, but varied from 0 to about 70cc.

Results of oil-in-the-water column sampling have not indicated the presence of oil at levels above that considered to be background. However,

since the oil tended to break into smaller pieces through mechanical action, it is possible that the small sample sizes were too inadequate for us to be confident that there was in fact none below the surface in particulate form.

One of the more interesting observations was the presence occasionally of a blob of oil, up to about a meter in diameter, lying on the surface of an ice flow, near its centre, with no visible oil elsewhere on the pan or around it. One possible and likely explanation is that individual blobs of oil as this were thrown up there by wave action when the pan was at the edge of the ice field.

III. Ice Movement Inshore of Cape Breton Island

The ice-oil stain seen on 23 March, moved persistently and discretely to the northeast during the following 2 days at a mean rate of 8-10 miles per day. This drift is opposite to the expected general southwesterly movement of the Scotian Shelf current. The extent to which this motion was affected directly by the wind versus the water currents is not known. However, it was interesting to note that during the morning of March 25th, when the ice was moving at nearly 1 knot to the northeast, there was generally less than 5/10 coverage in the vicinity of Fourchu Head. It seems more plausible then that the water currents, rather than the direct effect of the wind, were primarily responsible for the ice motion.

Other observers (Ingram, 1972, J. Fish. Res. Bd: 130,121-123) have also noted a northeast movement of the ice in this inshore area. Thus it may well be that a clockwise eddy is present in this area, and is controlled by the larger scale circulation pattern. If this is the case, then it seems likely that this northeasterly ice movement will eventually swing around and move to the southwest a little further off the coast. If such an eddy-system does exist then any oil slicks caught in the eddy currents will persist in this area inshore of Cape Breton Island until such time that this surface water mass again joins the Scotian Shelf current and moves further southwest.

IV. Oil Budget

In Ice: We found no way to accurately evaluate the amount of oil that was in the ice. However, we did attempt to "guesstimate" the quantity observed in the major nearshore oil-ice streak. With a mean width of 100m and a mean oil film thickness of 1 mm, this streak (5000 m length) would contain 500 m^3 of oil.

From the ships track through the ice and from helicopter flights it appears that this one major streak may have constituted up to 20% of the total contained in this ice field. Therefore, the total amount contained in the ice in this area may have been as much as 2500 tons, i.e. about 1/3 of the total amount spilled from the tanker.

Oil at Surface in Open Waters: During our sampling program the CSS Hudson ran a course in open water near the edge of the ice, and roughly parallel to it. The oil, as measured in the surface net tows, appeared to have been previously associated with the ice and may have been in the process of being released from it. This particular "patch" of oil appeared to be mainly confined to an area about 100km long by 20 km wide. From 11 oil tows in open waters within this area, the average amount of oil/tow was estimated to be 15 cm^3/tow, with each tow estimated to sample a surface area of 300m^2. Thus:

Total volume of oil in open water near ice

$$= \frac{2 \times 10^9}{3 \times 10^2} \times \frac{15}{106} = 100M^3$$

Thus it appears that as of March 25 most of the oil observed near Pt. Michaud was still trapped in the ice. However, if the initial spill from the tanker was circa 7500 tons, then there is some 4000-5000 tons of oil still unaccounted for.

SUMMARY

1. A large oil-stained ice streak, containing an estimated 500 m^3 of oil, was investigated inshore of south-east Cape Breton Island by helicopter and from the CSS Hudson.
2. Without proper ground-truthing is was not possible to accurately distinguish oil-stained ice from sediment-stained ice. In fact, in

some instances staining due to algae was mistaken for oil contamination.

3. Most of the oil at sea consisted of a mixture of lumps, blobs and smaller particles, with a large part of the staining due to sand-grain sized particulate oil.

4. Most of the oil appeared to be on the sea surface between the ice-floes. There probably was not any large quantity of oil extending underneath the ice in this region.

5. Inshore oil in ice (off Pt. Michaud) was moving northeasterly, opposite to the general current pattern, suggesting the presence of a clockwise eddy in the area Pt. Michaud to Gabarus. This system delays the continued southwesterly movement of oil slicks, keeping them in the Cape Breton Island region.

6. Preliminary calculations of an oil budget for the southeast coast of Cape Breton Island indicate that up to 2500 tons of oil may be contained in ice here, with a further 100 m^3 at sea in open water near the ice.

7. In terms of new knowledge and information about behaviour of oil in the environment, it appears that attention focussed on the ice-oil mixtures would be the most profitable. This could be achieved in most cases most efficiently and more satisfactorily from a helicopter.

OIL-IN-ICE AND OIL-STRANDING OBSERVATIONS

J.H. Vandermeulen
Marine Ecology Laboratory

INTRODUCTION

Reports of oil-in-ice in inshore waters near the south-east Coast of Cape Breton shortly after the Kurdistan spill provided impetus to examine some of the various features of oil stranding on ice-covered shorelines, particularly since the earlier reports indicated that much of the oil coming ashore was in the form of blobs and particles (viz. Trites, this volume).

Accordingly an intensive helicopter overflight and sampling trip was arranged for March 28 and 29 to examine the presence of offshore oil in or near ice, to examine some of the features of reported oil-in-ice "streaks" near Chedabucto Bay, and to examine some details of stranded oil on ice-covered beaches.

OBSERVATIONS

The field crew included, besides the author, H. Wiele (B.I.O. photography) and G. Harris (EPS).

The flight path included a 15-mile wide zigzag offshore leg, running from Gabarus north and northwest to Sydney, plus a detailed inshore leg from Gabarus south to Point Michaud. The latter portion included several shoreline stops, and some landings onto some of the larger ice-floes offshore.

1. CHEDABUCTO BAY

Most of the inshore coastline of Chedabucto Bay was covered by broken ice and slush ice (Slide 17 and Plate 1). In various places discoloration of ice was observed, giving the appearance of oiling (Slides 18,19,20). However, on closer examination after landing the helicopter and on-foot inspection, the general discoloration appeared to be due instead to some organic streaking. These discolored stains or streaks were 3-7 m wide and 15 to

30 m long, and more or less followed the contour of the shoreline. No oiling was seen anywhere in the Chedabucto Bay area on these dates.

2. PT. MICHAUD TO SYDNEY. - OFFSHORE

Outside of Chedabucto Bay on the Atlantic side of Pt. Michaud the ice was much more heavily packed together, consisting of floes mixed in with brash-ice and rotting ice (Plate 2). The number of oiled floes was very small, however. During the entire overflight from Pt. Michaud to Sydney, including a 15 miles wide zig-zag pattern, no more than a couple of dozen oil-blob marked floes were seen. Oil on floe surfaces was undergoing melting, and with it some of the ice surface underneath. Frequently such oil blobs floated in water-filled shallow depressions in the floe surface (Plates 3 and 4). This was similar to the situation onshore where oil spatter had melted into the shore pack and drift ice, and appeared to be enhancing rotting of the stranded ice.

We landed on several floes and obtained samples of oil from oiled floes for later analysis. Even on such close examination most floes appeared clean of oil except for occasional oil adhering to the floe edges. However, several lumps (fist size) of oil were seen floating amongst the floes in the water on or near the surface (Plate 5). The incidence of these lumps and smaller oil particles in the water surface appeared to increase as one got closer to shore.

Curiously, on two occasions we observed large ice-floes with oily smears on their upper-surface (Plate 6). Closer examination showed these oily smears to be true smears, as if a large oil blob had been streaked out broadly over the ice surface. From our observations it appeared possible that this might possibly have been done by seals crawling over the floe surface.

We encountered the ice-pack in Cabot Strait, and again observed streaks of discoloration in the ice, this time clearly caused by sediment (silt) carried through Cabot Strait (Plate 7,8) from the Northumberland Strait.

Our general overflight survey extended offshore 5 miles from Sydney, 15 miles off Louisbourg and back down to Chedabucto Bay (Plate 9). During this entire time we observed no sheens or large accumulations of oil or tar. Visibility was perfect, with a cloudless sky and calm winds and weather.

3. PT. MICHAUD TO GABARUS - INSHORE

Inshore intertidal water contained a large amount of particulate oil, ranging in size from a few millimeters down to sub-millimeter scale. One could not dip one's hand into the inshore water without instantly having the hand oiled with from ten to twenty small oil particles (Plate 10, 11). The onshore ice debris was liberally spattered with these oil particles to the extent that the shore ice had slight brown appearance (Plate 12). This was observed both for a small island offshore from Pt. Michaud, and to a lesser extent for shore-ice between Pt. Michaud and Fourchu.

Onshore the stranded shore ice had a pitted surface appearance, unlike the shiny smooth surface seen elsewhere as in Chedabucto Bay (Slides 21,22,23). The pits were glazed or filmed by thin oil layers or veins of oily threads. In several cases we observed such oily pits to have penetrated completely through the ice (Slide 24). Presumably this was due to heating from the sun warming up the oil spatters, which in turn caused the underlying ice surface to melt faster than that of the non-oiled clean ice surfaces around the oil droplets and spatters (Plates 13,14).

Size range of the oil particles was surprisingly wide, and unlike anything seen at the Amoco Cadiz spill in 1978. In that case the oil came ashore as mousse in large rivers and sheens. In the present case we saw no oil, mousse or oil sheens. The oil droplets themselves appeared quite weathered, with a fairly firm external texture. Larger blobs that were flung up onto the shore-ice with the incoming waves tended to splatter or break up into smaller droplets (Plate 15), but the breakup of these blobs again resulted in fairly discrete smaller blobs and droplets. However, some of the larger blobs caught up in ice crevices under the influence of the sun's heating tended to melt and run out over the ice surfaces (Plate 16).

This fragmentation or particularization of the Kurdistan oil was an unexpectedly new phenomenon, one that will likely cause considerable problems in cleanup. Certainly a large part of this stranded oil, the finer particulate form, will never be cleaned up. From the appearance of the particles in the water column it would seem that their formation did not occur near the inshore, but somewhere out at sea, or at least, elsewhere. The particles appeared too firm to lend themselves to much further breakup, and it appears likely that their fragmentation occurred at some earlier time when the oil was still less weathered.

There appear to be several routes of fragmentation - one at sea by wave action or possibly by ice-floe grinding. The second route occurs on shore, by spattering and subsequently by melting, spreading out and again forming smaller droplets. One over-riding factor in all these processes or steps would be the cold temperature of the water, which would tend to maintain the droplet shapes rather than allow further smearing out of the oil.

One puzzling aspect was the obvious absence of any sheen oil. Even onshore, on ice surfaces, there was no sheen oil evident under the sun's heating. From this it would appear that much of the lower boiling ends of the Bunker C would have weathered off, suggesting vigorous weathering between March 15 (time of the spill) and March 28 (this sampling date).

SUMMARY

1. A helicopter survey flight of offshore waters and ice of eastern Cape Breton Island revealed no oil at sea in any amounts. Streaks of stained ice within Chedabucto Bay near Ardoise and Pt. Michaud proved to contain sediment.
2. There was considerable oiling of stranded ice on the shore of St. Esprit Island, and to a lesser extent along the main shore of eastern Cape Breton. This oiling was largely in particulate form, with a wide size range from dinner-plate size down to less than one millimetre diameter particles.
3. Oiled stranded shore-ice appeared to be melting differently from non-oiled shore-ice, presumably due to the heat gathering capacity of the dark brown to black oil droplets.

4. Offshore no oil was seen except for a few single blobs lying on the surface of floes. On two cases such blobs had a "smeared-out" appearance, as might have been caused by seals crawling over the floe surface.

5. The oil coming ashore on March 28 and 29 had a highly weathered appearance, and at no time was sheen oil observed.

6. Judging from the particle size of the oil it is likely that much of the stranded oil will escape cleanup, and will become part of the shore debris.

Plate 1. Movement of ice floes and ice debris inshore in Chedabucto Bay.

Plate 2. Ice-field offshore from Chedabucto Bay near Point Michaud.

Plate 3. Oil plaque on surface of ice-floe offshore from Cape Breton Island. Note oil staining edge of floe..

Plate 4. Detail of oil plaque melting into floe-surface.

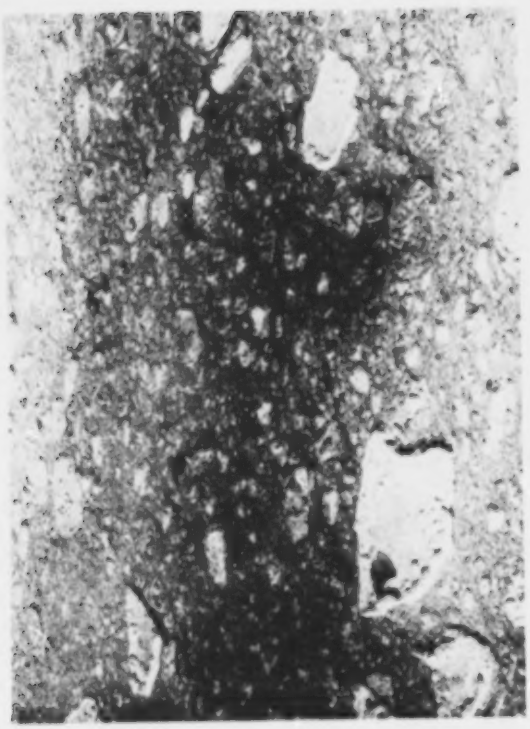


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Plate 5. Sampling tar lump from floe-edge, offshore Cape Breton Island, March 28, 1979.

Plate 6. Smeared oil streaks on surface of ice-floe, March 28, 1979. Such smearing did not appear to be the result of spattering, but appeared caused by seals.

Plate 7. Sediment streak in shore-bound ice in Cabot Strait, March 28, 1979.

Plate 8. Detail of sediment-stained ice.

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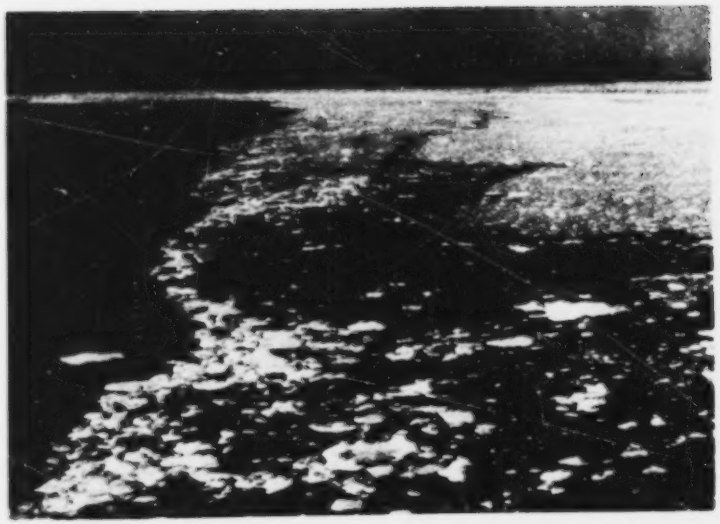
Plate 9. Ice-field in Cabot Strait, March 29, 1979.

Plate 10. Micro-particulate oil on shore-bound ice, St. Esprit Island, March 28 to 29, 1979.

Plate 11. Floater jacket stained by micro-particulate oil from intertidal zone.

Plate 12. Micro-particulate oil stained ice in intertidal zone, St. Esprit Island, March 28 to 29, 1979.



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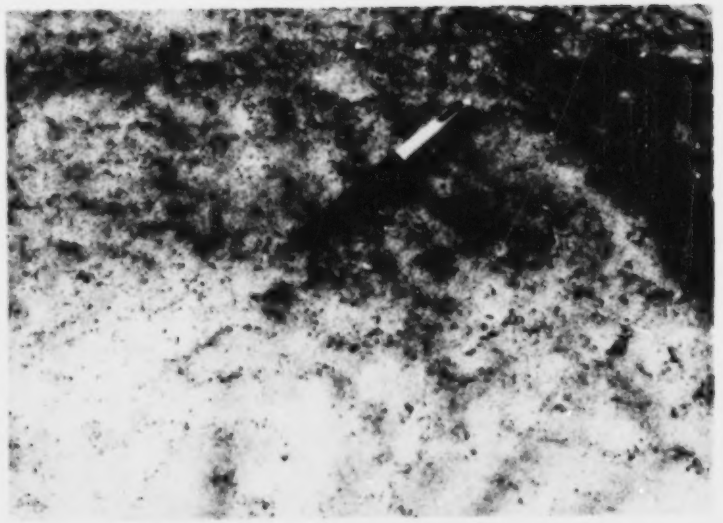

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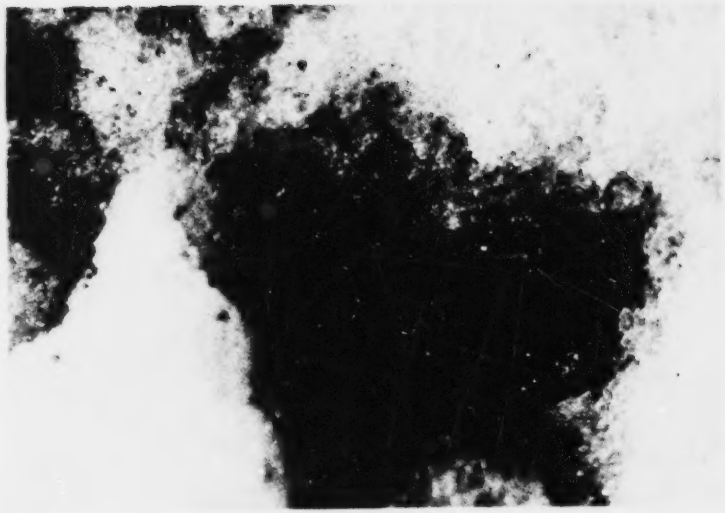
Plate 13. Detail of oiled ice-pocket, St. Esprit Island, March 28 to 29, 1979.

Plate 14. Oiled melt-depressions in shore-ice, St. Esprit Island.

Plate 15. Oil spatter in intertidal zone ice, St. Esprit Island.

Plate 16. Detail of oiled melt-hold and oil running over shore-ice under influence of sun's heat, mid-day, March 28, 1979.



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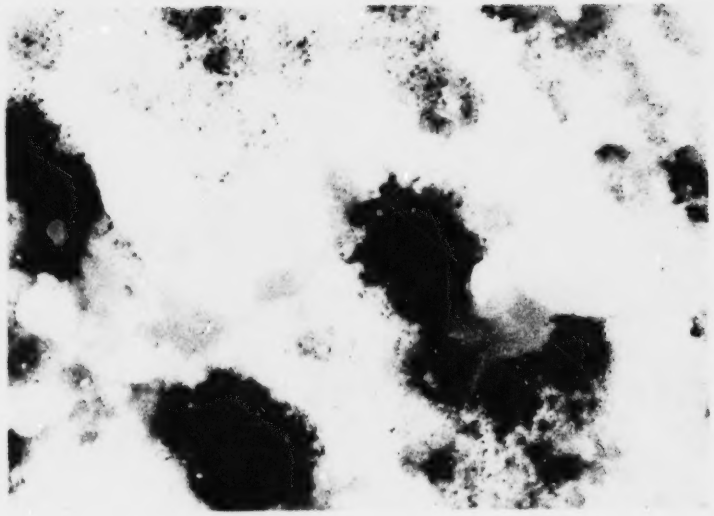

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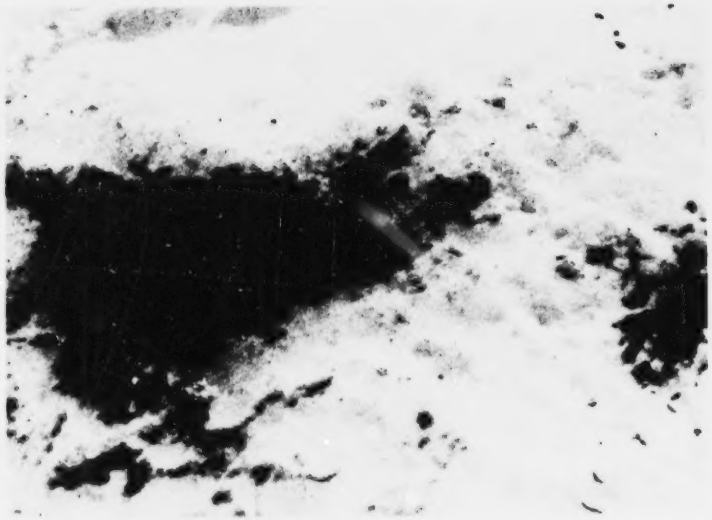

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III. Coastal Oiling Studies.

SENSITIVITY MAPPING OF NOVA SCOTIA COASTLINE: GUYSBOROUGH COUNTY AND CAPE BRETON.

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INTRODUCTION

The breakup of the oil tanker KURDISTAN off the Cape Breton coastline in mid-March resulted in an immediate need for an assessment of sensitivity of that shoreline in the event of oiling. Since shoreline maps for the region were non-existent the Environmental Protection Service (EPS), the agency responsible for onshore pollution cleanup, requested an immediate assessment of the morphological characteristics and environmental sensitivity both of the Cape Breton shoreline and of the Guysborough County shoreline of the Nova Scotia mainland.

This report provides a preliminary study of these coastlines, combining existing maps, charts, air photographs and other relevant information at our disposal. We also rely heavily on results from a preliminary but extensive photographic reconnaissance of the Cape Breton coastline carried out shortly after the KURDISTAN tanker breakup, as part of the Bedford Institute of Oceanography scientific response.

The report consists of two parts with accompanying maps. Part 1 (with Map No. 1) describes the area from Glace Bay to Point Michaud on Cape Breton Island. Part 2 (with Map No. 2) covers the Eastern Shore of mainland Nova Scotia, from Hartlen Point to Cape Canso. Each assessment was completed within two days of the initial requests and was supplied to EPS on March 21 and March 28. Since both reports were compiled using only existing published information and maps, without first-hand field observation, the shoreline geomorphology (particularly in Map No. 1) should be considered preliminary; in this context the descriptive terms refer to regional trends rather than site-specific trends. For example, the term "sandy beaches" refers to beach shorelines that are likely to contain a significant amount of sand-sized sediment, whereas "pebblecobble beaches" are those shores that consist predominantly of coarse-grained beach materials.

The distribution of marshlands indicates the areas in which marsh wetlands are most prevalent; it does not refer to the precise area distribution of the marshes.

PART ONE - GLACE BAY TO POINT MICHAUD

DATA BASE

The north Chedabucto shoreline has been mapped (to Point Michaud) by Owens (1971). Published map information, on the coastal sector from Point Michaud northward to Glace Bay, is virtually non-existent. This assessment was prepared from the following sources of data:

1. Geological map of Nova Scotia,
2. 1:75,000 hydrographic charts,
3. 1:50,000 topographic maps,
4. Dalhousie University, Institute of Environmental Studies; Maintenance of beaches technical report,
5. Owens, 1977, Coastal Environments of Canada: the impact and clean-up of oil spills: EPS Kept. - 3-EC-77-13,
6. a set of black and white oblique aerial photographs obtained by R. Belanger and D. Buckley during a BIO/AGC aerial reconnaissance,
7. surficial geology map of Nova Scotia, from Maritime Water Resources study, Atlantic Development Board, 1969.

The above data base is not adequate enough for a thorough documentation of the characteristics of the coastline. However, it is sufficient to provide a basic framework for use in emergency oil-spill contingency planning.

COASTAL ZONES

This sector of coast is divided into three zones (based on geology, coastal physiography, shoreline types, etc.) as follows:

Zone 1 - Glace Bay to Mira Bay South Shore - ScatarieIsland,

Zone 2 - Scatarie Island to Head of Gabarus Bay,

Zone 3 - Head of Gabarus Bay to Point Michaud.

ZONE 1 - GLACE BAY TO SCATARIE ISLAND

a) General Description

Rock-cliffed coasts (5 to 20 m elev.) of low-resistant Permo-Carboniferous sandstones, till cover thin to absent; characterized by three large, northeast trending bays containing bayhead barrier beaches, which enclose large lagoonal estuaries.

b) Tidal Range and Wave Exposure

1m; bayheads exposed to wave fetches up to 500 metres in northeast directions.

c) Shoreline Characteristics

Length - 620 km

Percent beaches - 26%

Percent cliffs - 74%

No. of tidal inlets - 7

Trends - sand barrier beaches at bayheads, coarse-grained beaches, bay flanks, to rock cliffs seawards.

d) Vulnerable Areas

Barrier beaches at the head of Glace, Schooner, Morien, and Mira Bays. All these beaches face northeast, are composed primarily of sand, and are in the order of a few hundred metres (or less) in width. Every barrier beach is cut by at least one inlet.

e) Accessibility

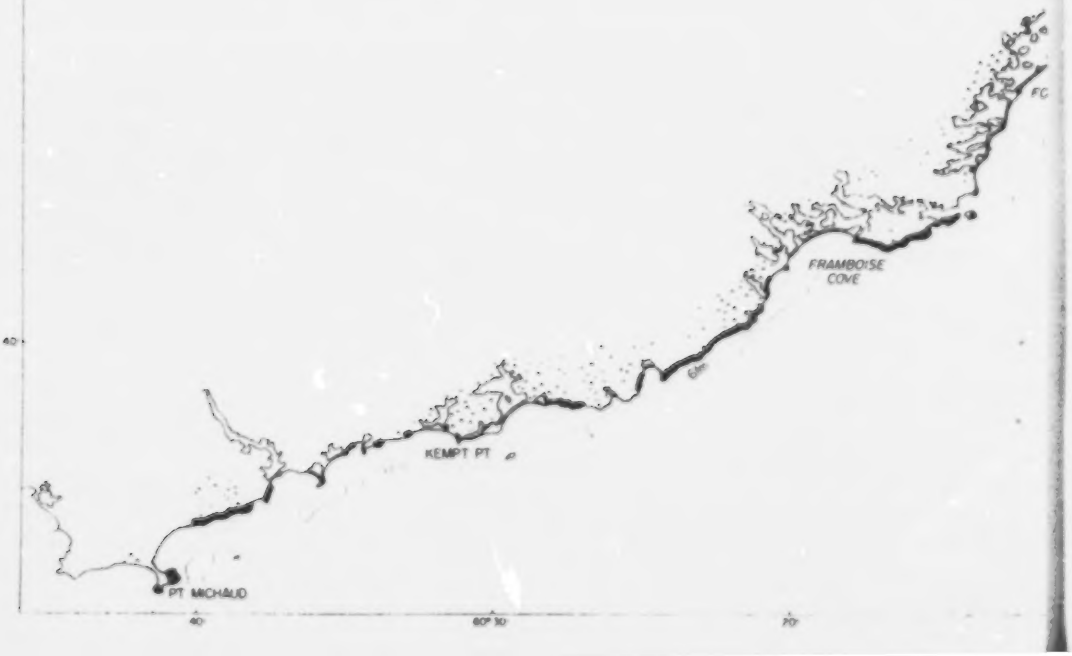
All major beaches are easily accessible by road. Would allow movement of equipment, vehicles and manpower. Most of this coastal zone has good overland access.

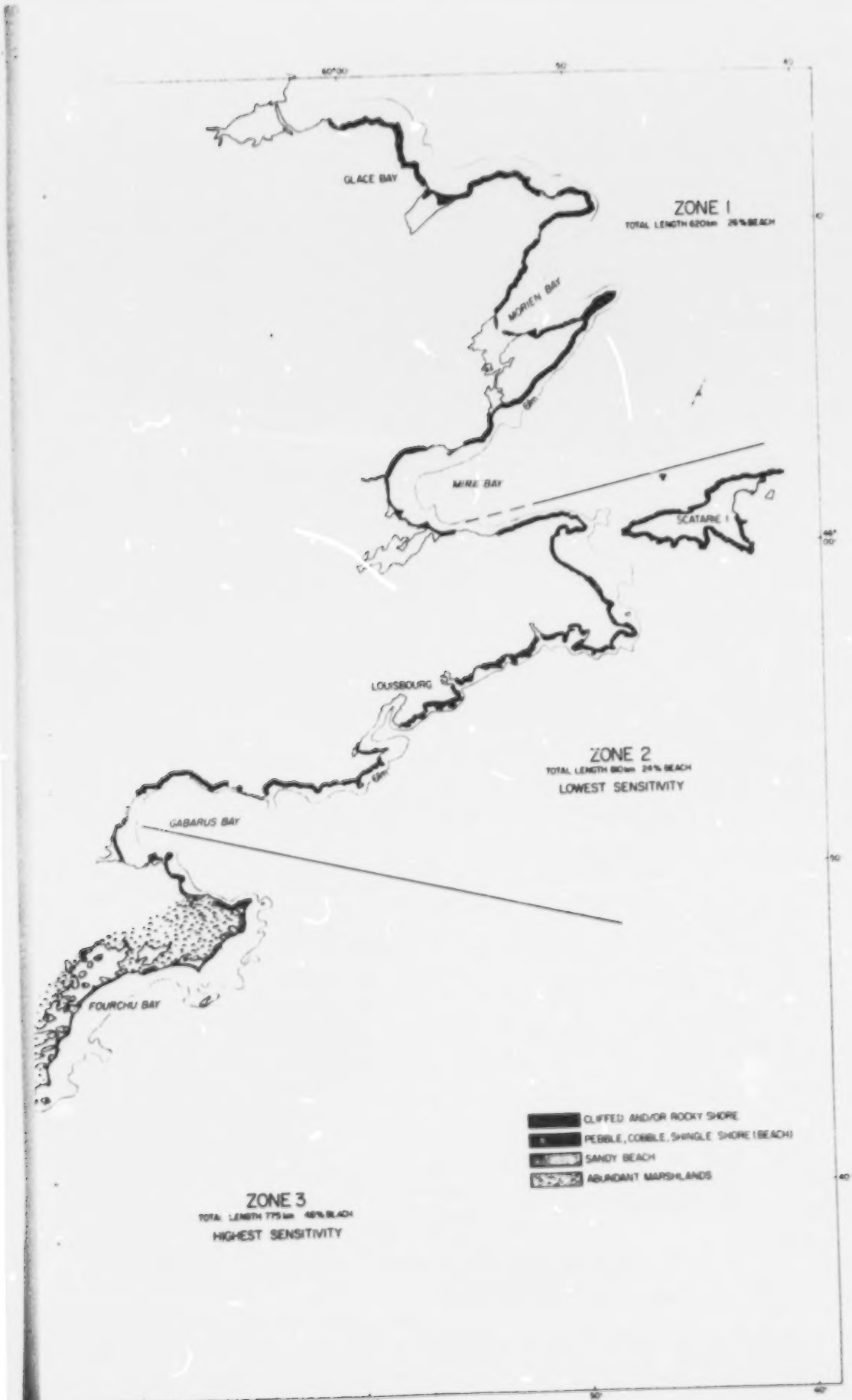
f) Protective Measures

1. Barrier beach and lagoon systems should be concentrated upon; particularly the areas at the heads of the main bays.
2. All tidal inlets should be boomed to prevent oil from entering the lagoons. (Contrary to what the hydrographic chart indicates, there is no barrier beach across False Bay, on the north shore of Mira Bay. The mouth of this bay should be boomed also, because it is connected to the lagoon at the head of Morien Bay.)

GLACE BAY to POINT MICHAUD

MAP No 1 MARCH 21, 1979




GLACE BAY
ZONE 1
TOTAL LENGTH 620km 26% BEACH
MORIEN BAY
MIRE BAY
SCATARIE I.
LOUISBOURG
ZONE 2
TOTAL LENGTH 80km 24% BEACH
LOWEST SENSITIVITY
GABARUS BAY
FOURCHU BAY
CLIFFED AND/OR ROCKY SHORE
PEBBLE, COBBLE, SHINGLE SHORE (BEACH)
SANDY BEACH
ABUNDANT MARSHLANDS
ZONE 3
TOTAL LENGTH 775km 48% BEACH
HIGHEST SENSITIVITY

3. The barrier-beach systems, which extend only about 2-3 m above mean low water (such as at Dominion Beach), should be dyked at the high-water line using material from the beach face. These low-relief beaches are cut by overwash channels, and oil approaching the shore under high wave energy conditions and/or spring tides could easily be carried through these channels into the back barrier lagoons. Depending on the wave conditions, some of the overwash areas may require additional barricading.

4. The beaches that have a steep backshore consisting of coarse storm ridge deposits (such as what appears to be present, from the oblique photographs, at some of the Mira Bay beaches), should be given a lesser priority in terms of dyke construction than the the low-relief sand beaches. However, if oil is approaching the shore under storm-wave conditions, the major beach segments should all be dyked. These segments are:

i) Mira River - Catalogne Lake, Mira Bay,
ii) Barrier beach at head of Morien Bya,
iii) Schooner Cove,
iv) Barrier beach at Dysan's Pond - Glace Bay.

5. Rocky shores are generally vertical cliffs; nothing should be attempted to protect these shores.

ZONE 2 - SCATARIE ISLAND TO HEAD GABARUS BAY

(a) General Description

Low lying, highly resistant coastline consisting largely of Precambrian metamorphic rocks, with till cover of variable thickness and occasional drumlins; except for those on Scatarie Island, the rock and till cliffs are generally less than 10 m in elevation; characterized by low-sloping rock shore platforms (numerous shoals and reefs) often overlain by till bluffs, and by coarse-grained (cobble, pebble), mainland-attached and pocket beaches; small openended bays, (i.e.; Louisbourg and Baleine Cove).

(b) Tidal Range and Wave Exposure

≈1 m tidal range; east to east-southeast facing, exposed to north Atlantic swell, except in lee of Scatarie Island; high wave energy expended close to shore because of steep nearshore gradient compared to Zone 1 (6 fathom line situated relatively close to shoreline).

(c) Shoreline Characteristics

Length - 810 km

Percent beaches - ≈24%

Percent cliff and sloping rock shores - ≈76%

No. of tidal inlets - 1(?) - east side of Scatarie Island

Trends - no significant barrier beach or lagoon development, only three large sandy beach areas (Main-à-Dieu, east side of Scatarie Island, and double tombolo south of Cape Breton). Beaches are mostly coarse grained, pebble-cobble, Beaches commonly occur adjacent to and overlying low-sloping rock shore platforms; coarse-grained perched storm-ridge deposits in some exposed areas.

(d) Vulnerable Areas

Main-à-Dieu and east Scatarie Island sandy beaches, Louisbourg Bay, and the coarse-grained east- and southeast-facing pocket beaches.

(e) Accessibility

Apart from the Louisbourg and Main-à-Dieu regions, the shoreline is not as easily accessible for onshore protection activities, as Zone 1. Most of the small cover and beach tracts will be nearly impossible to reach within a reasonable time frame. A main road runs along the north shore of Gabarus Bay from the head of the bay to Louisbourg.

(f) Protective Measures

1. Louisbourg Bay and the harbour at Fortress of Louisbourg should receive top priority in any onshore protection scheme. Entrance to Louisbourg Bay is fairly wide, but attempts should probably be made to boom it.
2. Main-à-Dieu harbor (between the breakwaters) could be boomed easily. Likewise at Bay Lorraine, Little Lorraine and Baleine Cove.
3. Scatarie Island should receive low priority relative to the mainland.
4. The beach at Main-à-Dieu has a fairly steep gradient with a well-developed storm berm. It looks like a high wave-energy beach with an abundant sediment supply from local erosion of till cliffs. This beach could be cleaned up, if oiled, with far less adverse consequences than some of the other beach areas where sediment supply is scarce.
5. Coarse-grained beaches are highly susceptible to oil penetration. Two areas that should receive some consideration for protection are: (1) the region between Fortress Louisbourg and White Point and (2) north and south sides of Cape Breton. Spreading of sorbents to reduce permeability would help, i.e.: manure, straw, burlap, spread like a compost at or above the high water line.

ZONE 3 - HEAD OF GABARUS BAY TO POINT MICHAUD

(a) General Description

Predominantly lowland unconsolidated coast featuring abundant eroding drumlin till cliffs; subtidal shallow gradient rock platform with numerous reefs and rock shoals, platform rock forms base of till cliff headlands; characterized by narrow, relatively low-relief sandy barrier beaches connecting eroding drumlin cliffs, with numerous enclosed lagoons and extensive wetland and marsh areas.

(b) Tidal Range and Wave Exposure

≈1 m tidal range; high wave-energy coast, almost entirely exposed to Atlantic waves and swell; fairly straight coast relative to the other two zones.

(c) Shoreline Characteristics

Length - 775 km

Percent beaches - 48%

No. of tidal inlets - numerous, >14

Trends - abundant supply of sediment from eroding till cliffs and intense littoral processes have combined to create a dynamic beach dominated coastline.

(d) Vulnerable Areas

This segment of coast, in general, is highly vulnerable to contamination and long-term damage by oil. Barrier beaches are highly vulnerable (although they are usually steep-gradient beaches), because they are very narrow, consist largely of medium to coarse-grained sand with granules and pebbles, and have overwash channels cutting through the dune belt. Tidal inlets are small and numerous. The lagoon and marsh region behind the barrier beaches is the richest area for migrating shore birds in Cape Breton (Dalhousie University, Institute of Environmental Studies Report).

(e) Accessibility

Over-land accessibility is poor. There are a few major roads such as at Framboise Cove, Point Michaud and Kempt Point.

(f) Protective Measures

1. All the tidal inlets should be boomed. This could be done by helicopter.
2. At this time of year the beach face may consist largely of coarse-grained materials (granules, coarse-grained sand, pebbles) with finer sand offshore in the subtidal zone. This

condition will favor oil contamination. Dyking should be carried out on the major beach tracts to prevent oil from contaminating the backshore. In some places the barrier beaches are so narrow that the proper placement and alignment of the dykes will be critical (i.e.: the dyking may induce overtopping of the barrier by waves rather than preventing it).

3. The Fourchu, Framboise, and St. Esprit Lake barrier-beach systems should be given high priority because of the extensive lagoon and marsh areas adjacent to these areas.
4. The use of sorbents, which could be rapidly deployed, should be strongly considered because of the large area that would have to be given protection, within a relatively short time (natural sorbents, such as burlap, manure, peat, ground rubber). Accessibility will be a problem.
5. If it appears that oil is going to contact the shore during storm wave and/or spring tide conditions, dyking and barricades should be constructed at the front of the dunes and at the mouth of overwash channels, etc. It is vital that no oil gets into the back barrier regions.
6. The mouth of Fourchu Harbor could be boomed easily; likewise the harbor at L'Archevêque Cove.
7. The first priority in this zone is to keep the oil from getting into the back barrier regions. The beaches are subjected to high-wave energy and therefore to self-cleansing; the marshes and lagoons are not. Protecting the lagoon-marsh, while allowing the beaches to be oiled, might be a viable strategy given the poor accessibility in this region.

TIMING OF OIL IMPINGEMENT

Predicted tide tables indicate that the tides will be approaching maximum range (spring tides) in the week of March 25 to March 30 (1.2 m range, March 29). Minimum tidal ranges (neap tides) are predicted for the week of April 2 to April 7 (0.7 range, April 5). Clearly, the barrier-beach shoreline will be more vulnerable to extensive contamination during the spring tides than during neap tides. Protective methods will to some

extent be dictated by the tidal phase and the wave-energy conditions at the time of impending oil encroachment on the shore. Neap tidal conditions and low wave energy would facilitate more effective protection, and would also minimize subsequent cleanup operations.

OVERALL ASSESSMENT - PART 1

1. Zone 3 is liable to extensive contamination and long-term damage by oil impingement. It is also the most difficult, of the three zones, in which to launch an effective onshore protection scheme.
2. Zone 2 is the least vulnerable (of the three zones) to long-term damage by oil spillage. Louisbourg Harbor is an exception and should be given special protective consideration.
3. Zone 1 is the area in which it will be relatively easy, compared to the other two zones, to launch an effective onshore protection scheme.

NOTE: Map No. 1 accompanies this brief.

PART 2 - HARTLEN POINT TO CAPE CANSO

DATA BASE

This assessment was prepared using only limited data available for this region. Sources of data which were drawn on include the following:

1. Preliminary information from a shoreline mapping study presently being undertaken (DSS Contract) by H.D. Munro,
2. 1:50,000 topographic maps,
3. hydrographic charts,
4. Owens, E.H. and Bowen, A.J., 1977, Coastal environments of the Maritime Provinces. Maritime Sediments, v. 13, p. 1-31,
5. Owens, E.H., 1977, Coastal Environments of Canada: the impact and clean-up of oil spills. EPS Rept. - 3-EC-77-13,
6. unpublished data of Coastal Geodynamics Group, AGC.

COASTAL ZONES

This entire coastal sector is made up of low resistance metasedimentary and granitic rocks, which are covered by varying thicknesses of glacial till. It is a lowland, highly indented coast with rock and till cliffs to 10 m, and locally, drumlins to 30 m in elevation. There is systematic variation in coastal physiography and submarine topography along this coastal sector. This variation has produced a trend in the distribution of shoreline types, which combined with physiography, enables a division into four coastal zones as follows:

Zone 1 - Hartlen Point to Stoddart Point,
Zone 2 - Stoddart Point to Liscomb Point,
Zone 3 - Liscomb Point to New Harbour,
Zone 4 - New Harbour to Cape Canso.

ZONE 1 - HARTLEN POINT TO STODDART POINT

(a) General Description

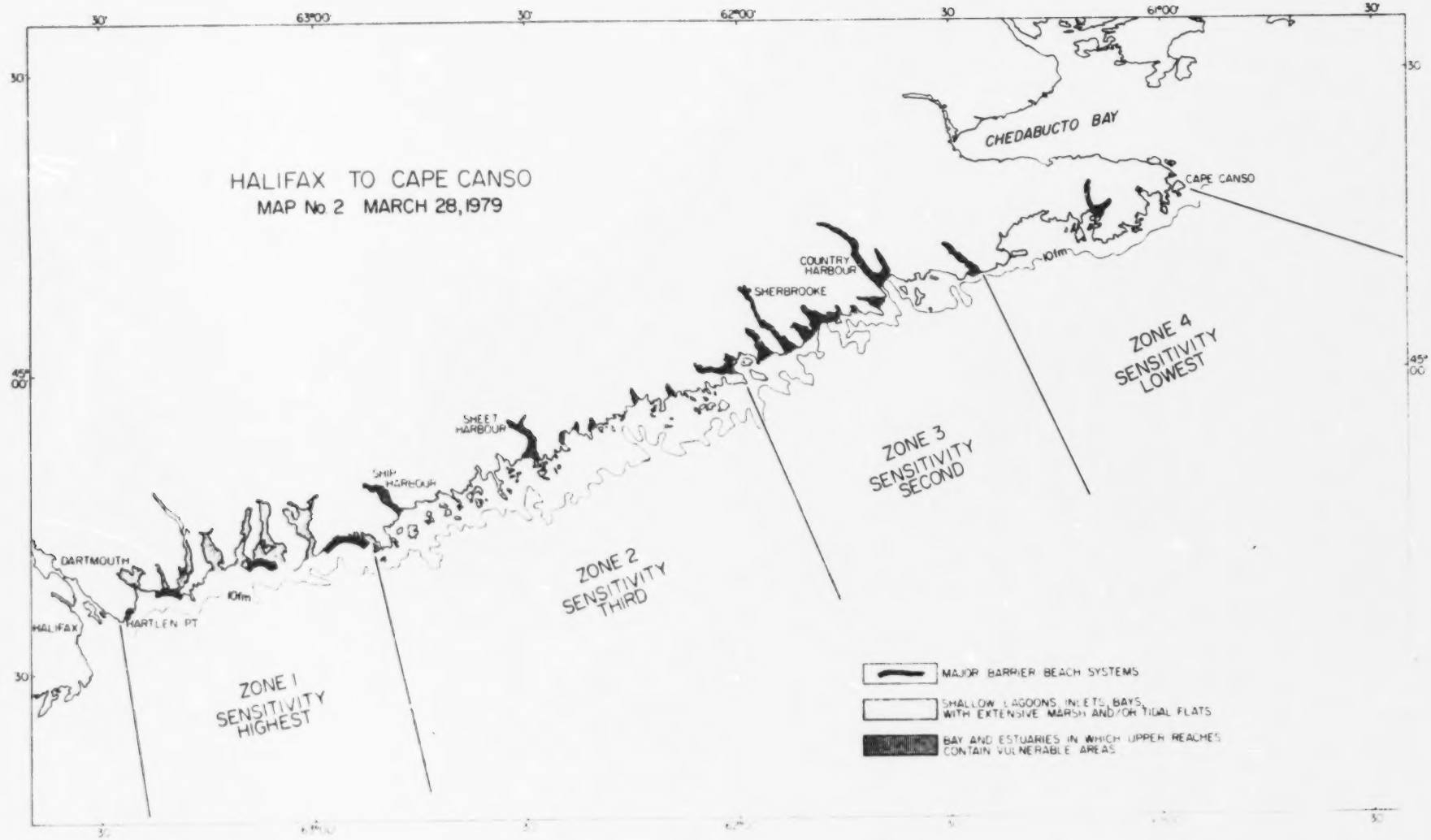
Characterized by exposed bedrock and till-cliff headlands and deeply indented embayments, which are often partially enclosed by barrier beaches and spits. Lagoons and bays exhibit extensive tidal flat and marsh development.

(b) Tidal Range and Wave Exposure

Mean 1.4 m; headlands and beaches almost completely exposed to high-wave energy; partially enclosed bays and inlets are low-wave energy environments.

(c) Distinguishing Coastal Features

1. Sand-fine gravel barrier beaches adjacent to exposed headlands (i.e.: Martinique, Lawrencetown)
2. Bays and lagoons containing abundant intertidal flat and marsh areas (i.e.: Petpeswick Inlet, Clam Harbour).


HALIFAX TO CAPE CANSO
MAP No. 2 MARCH 28, 1979
63°00'
62°00'
61°00'
30'
45° 00'
CHEDABUCTO BAY
CAPE CANSO
COUNTRY HARBOUR
SHERBROOKE
SHEET HARBOUR
SHIP HARBOUR
DARTMOUTH
HALIFAX
HARTLEN PT
10fm
ZONE 1 SENSITIVITY HIGHEST
ZONE 2 SENSITIVITY THIRD
ZONE 3 SENSITIVITY SECOND
ZONE 4 SENSITIVITY LOWEST
MAJOR BARRIER BEACH SYSTEMS
SHALLOW LAGOONS, INLETS, BAYS, WITH EXTENSIVE MARSH AND/OR TIDAL FLATS
BAY AND ESTUARIES IN WHICH UPPER REACHES CONTAIN VULNERABLE AREAS

(d) Most Vulnerable Areas

1. Shallow lagoon systems (marsh and tidal flats) of Cow Bay, Cole Harbour, West Marsh, Lawrencetown Lake, Chezzetcook Inlet, Petpeswick Inlet, Musquodoboit Harbour, Jeddore Harbour, Clam Harbour.
2. Barrier beaches at Martinique, Lawrencetown, Clam Bay, Cow Bay. All these beach systems exposed to high-energy waves, are relatively low and narrow; therefore can be overtopped by storm waves; all these beaches protect shallow lagoon-marsh-flat areas.

(e) Accessibility

All major beaches are easily accessible by road. Most of this coastal zone has a good overland access.

(f) Protective Measures

1. Protection of lagoon marsh and tidal flat areas should receive top priority. This could be done in most cases by booming or temporary barricading the tidal inlets and entrances at the following localities (all of relative equal priority):
   (i) Cow Bay - south end of barrier beach - maybe could be temporarily dammed (≈100 m width).
   (ii) Cole Harbour - two booms across entrance to harbour, connecting island to mainland.
   (iii) Lawrencetown Lake - two bridges to Fox Island and Lawrencetown beach could be easily boomed; the entrance to the backwater behind Fox Island should also be barricaded.
   (iv) Porters Lake - railway and highway bridges at Rocky Run are excellent spots for a dual boom system.
   (v) Inlets at Clam Harbour, Little Harbour, and Sleepy Head are relatively narrow and could be boomed readily.

   Areas that should receive top priority but where booming or temporary barricading will be difficult are the following. It

should be noted that protection on these areas will be extremely difficult.

(i) Chezzetcook Inlet - entrance too wide (≈800 m) and too exposed to boom. Probably better to protect the upper reaches by booming across to the islands; the backwater at Grand Desert could be easily amenable to booming (at the bridge).

(ii) Petpeswick Head - only feasible place for booming would be halfway up the bay at the town of Petpeswick Harbour, where the bay narrows to ≈250 m; backwater behind Petpeswick Head should be protected.

(iii) Musquodoboit Harbour Area - the entrance can not be sealed off. There is an extensive marsh and lagoon system with a bird sanctuary behind Martinique Beach. Probably only a part of it could be protected with an intricate boom arrangement between the many islands. Accessibility is poor, and would have to be done by helicopter probably. The bridge across Oyster Point Inlet at Pleasant Point (about 100 m width) should be boomed.

(iv) Jeddore Harbour - a long boom network could be attempted between the wharves at East and West Jeddore (width of channel is ≈650 m).

2. Ocean beaches should receive second priority in any protection scheme. Some of them, such as the Martinique beach, could be dyked at the high water line. The beaches with major dune blowouts and overwash channels should receive particular attention. The overwash and blowout conduits should be barricaded at the seaward side to prevent high-wave driven oil from entering the back barrier marsh-lagoon regions.

3. The major beaches which should be given first priority for beach protection planning are Martinique, Lawrencetown and the Clam Bay - Clam Harbour beaches.

4. The sand beaches are high-energy beaches, and probably have some degree of 'self-cleansing' over the long term. In any

protective scheme priority should be given to the lagoon and marsh areas.

5. Rocky shores and till-cliff headlands cannot be protected adequately. In any case these are generally 'high-energy self-cleansing' areas and should be ignored in any protection scheme.

ZONE 2 - STODDART POINT TO LISCOMB POINT

(a) General Description

Highly-indented, irregular coastline with numerous shallow bays, Ship Harbour Bay and Sheet Harbour estuary being the only exceptions. Shore-lines are predominantly bedrock, with occasional veneer of boulders and cobbles and with boulder-cobble pocket beaches. Characterized by low-gradient offshore platform with numerous bedrock islands, reefs and shoals.

(b) Tidal Range and Wave Exposure

Mean 1.4 m; moderate to low-energy wave environment, wave energy expended on complex offshore island and shoal region.

(c) Distinguishing Coastal Features

Numerous bedrock islands, reefs and shoals.

(d) Most Vulnerable Areas

The small areas in the inner parts, and at the heads of bays, where swamp-marsh wetlands occur.

(e) Accessibility

Most of the mainland shoreline is accessible by road, especially the heads of bays. A lot of the seaward headlands are inaccessible. Abundant offshore islands are obviously relatively inaccessible.

(f) Protective Measures

1. It will be virtually impossible to launch protective measures on most of this shoreline because of general inaccessibility. The offshore islands compound the problems of protection and cleanup methods.
2. On an areal basis, there are few vulnerable localities (relative to Zone 1) in this zone. This, combined with the difficulty of launching a protective scheme here makes this a low priority zone for protection schemes when compared to Zones 1 and 3.
3. Priority areas for protection in this zone would be the heads of bays where marsh-tidal flats are present. The areas listed below are localities where booms could be realistically employed (all are of relatively equal priority):
   (i) Sheet Harbour - boom Church Point to Mitchel Point (≈300 m width), also Church Point across East River (≈200 m width).
   (ii) Wharf at Port Dufferin - ≈250 m width.
   (iii) Extensive marsh and flats at the head of Quoddy Inlet - if impossible this area should be protected by booms deployed at Hartling (width of channel ≈400 m).
   (iv) Across neck (≈200 m wide) of Necum Teuch Harbour.
   (v) Smith Cove could be protected easily by running the booms from mainland to island to mainland (width of 100 to 200 m).
   (vi) Head of Ecum Secum Inlet where it is ≈150 m wide.
   (vii) Bridge at Baker Cove - to protect small marsh.
   (viii) Little Harbour at the wharves.
   (ix) Ship Harbour would be tough to boom because of exposure and currents - perhaps could be done at Beach Point where the harbour is ≈500 m wide.
   (x) Small tidal inlet to backwater at Taylor's Head could be barricaded easily (<100 m wide).

   There are other small bayheads and backwaters which would be

accessible for boom setup, but these should receive on-site consideration.

ZONE 3 - LISCOMB POINT TO NEW HARBOUR

(a) General Description

Characterized by large, linear deeply-indented embayments and estuaries; bay mouths are deep and very wide; headlands and bay flanks characterized by bedrock shorelines, occasionally with thin veneer of boulders and cobbles; well-developed beaches are extremely scarce.

(b) Tidal Range and Wave Exposure

Mean 1.4 m; moderate to high-wave energy, headlands and bay mouths exposed to deep-water waves because of relatively steep nearshore gradient and lack of abundant bedrock islands, reefs and shoals.

(c) Distinguishing Coastal Features

Coastline is deeply incised with large and deep, linear embayments and estuaries.

(d) Most Vulnerable Areas

Upper reaches of estuaries and bays.

(e) Accessibility

Relatively poor except in the upper reaches, and along flanks, of major embayments.

(f) Protective Measures

1. For the most part it would only be feasible to launch effective protective schemes in upper reaches of bay and estuaries. It would be difficult to boom the large estuaries which undergo both large freshwater input and large volume of tidal seawater exchange.
2. Protection schemes should be largely restricted to booming of upper bay and estuary regions where marsh and wetlands are

prevalent, or where extensive residential areas occur. Areas which could be boomed are as follows:

(i) Inner Liscomb Harbour.

(ii) Gaspereau Brook - near historic site.

(iii) St. Mary's River Estuary - boom across from Sonora, a distance of 250 m. This would protect almost all of St. Mary's estuary from contamination.

(iv) The tidal inlet at Wind Harbour could be boomed (≈150 m wide); as could the backwater at Barachais Cove.

(v) The Indian Harbour Causeway should be checked to see if a barricade is useful at this locality.

(vi) Fisherman's Harbour at the narrow neck (width of ≈200 m).

(vii) Country Harbour could be boomed at Green Point (≈500 m wide), or farther landward at Stormont (≈300 m wide).

(viii) Isaacs Harbour at seaward wharves (≈500 m wide).

(ix) New Harbour about 400 m seaward of highway bridge.

ZONE 4 - NEW HARBOUR TO CAPE CANSO

(a) General Description

Bedrock-controlled, sediment-starved shoreline; extremely irregular coastline with many inshore islands. Cobbles and boulders common overlying bedrock, few cobble pocket beaches also present. Except for Tor Bay, the nearshore shelf gradient is relatively steep compared to other zones.

(b) Tidal Range and Wave Exposure

Mean 1.4; Tor Bay coast partially protected from high-wave energy, because of configuration and shallow gradient offshore; rest of zone exposed to high-wave energy, which reaches well into shore where expended on islands and headlands.

(c) Distinguishing Features

Low-sloping exposed bedrock shorelines, with absence of significant amount of unconsolidated material; broad, shallow embayment of Tor Bay.

(d) Most Vulnerable Areas

There are few vulnerable areas relative to other zones; small inner harbours and reentrance in Tor Bay and Dover Bay.

(e) Protective Measures

1. Small indentations along Tor Bay shoreline could be boomed, i.e.: Gammon Cove, Weber Cove, Cole Harbour, the marsh in Molasses Harbour.
2. Inner Dover Harbour could be boomed at headland (width ≈200 m), so also could the bay near the mouth of Gaspereaux Brook in Dover Bay.
3. Northwest Arm near Doughboy Point, in Whitehaven Harbour, could be boomed (channel width ≈350 m).
4. All other areas are virtually inaccessible to protective strategies. Numerous inshore islands make realistic protection and cleanup schemes nearly impossible.

SENSITIVITY RANKING OF ZONES

(Relative to one another)

Zone 1 - Hartlen Point (Halifax Harbour) to Stoddart Point: highest susceptibility to long-term damage by oil impingement.

Zone 3 - Liscomb Point to New Harbour: intermediate.

Zone 2 - Stoddart Point to Liscomb Point: relatively low.

Zone 4 - New Harbour to Canso: lowest.

OVERALL ASSESSMENT - PART 2

In the event of the likelihood of a major oil spill impinging on the eastern shore of Nova Scotia (Halifax to Canso):

1. Attempts should be made to give Zone 1 maximum protection. Cleanup procedures would be both harmful and difficult in this zone. It's easier to protect this zone than clean it up.
2. Zones 2 and 4 would be the most difficult areas in which to launch a protective measures scheme. These zones are also the least vulnerable to long-term damage by oil impingement.

3. A protection scheme could be undertaken in Zone 3; the areas which are most vulnerable (upper reaches of bays and estuaries) are also easily accessible. Protection should be limited to these upper bay regions.
4. Specific areas within Zones 2, 3 and 4 that should be protected from impending oil impact should be decided upon at time of operation, when it can be predicted with more certainty where major concentrations of oil are going to come ashore.
5. With a major oil slick, and very little lead time, protection schemes should be concentrated in Zone 1, with the other three coastal zones receiving low priority.
6. The damming or filling in of channels is not an environmentally sound, nor a physically feasible strategy in this coastal sector. Booming methods are much more preferable because they are easy to deploy and perhaps more important, they are temporary features.

NOTE: Map No. 2 accompanies this brief; also, 1:50,000 topographic maps are useful when referring to this brief.

BEACH RECONNAISSANCE OF SOUTHEAST CAPE BRETON ISLAND IN SUPPORT OF OIL SPILL CLEANUP OPERATIONS

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INTRODUCTION

On March 15, 1979, the British tanker Kurdistan broke up off eastern Cape Breton Island. The spilled oil was subsequently prevented from reaching the shores by a wide band of mobile pack ice. During the initial threat of oil to the Cape Breton shores, a beach reconnaissance study was initiated (Reinson, this volume) to select shores which should and could be protected from oil and to collect baseline information about the coastline. In early April, after the ice had left the coast oil was reported along the Cape Breton shores, particularly in the Sydney-Glace Bay area. Soon it was apparent that the oiling was general, washing ashore in variable amounts from St. Ann's Bay in the north of Cape Breton to as far south as Canso in Guysborough County of the Nova Scotia mainland. Minor amounts of oil were also reported along the southern Nova Scotia shore as far west as Mahone Bay (viz. Appendix III, this report).

By May 2, 1979, much of the Sydney area had been cleaned. In response to a request by EPS (Environmental Protection Service), an assessment of the cleanup operations was carried out and some of the more severely oiled shores, e.g. the marsh of Big Glace Bay Lake, were examined. In addition, select beaches visited in late March were revisited to monitor changes in beach profile and in sediment character, and to document the amounts of oil on the beaches and/or assess cleanup procedures. This report details observations made of the coastline from North Sydney to Fox Main on Chedabucto Bay. A detailed list of sites visited is listed in an appendix to this report.

OBJECTIVES

The primary objectives of the beach reconnaissance were as follows:

1. identify the shores that had been oiled and which had been cleaned,
2. observe methods of cleanup,
3. assess the cleanup operation and the effects to the beaches,
4. examine the penetration of the Bunker-C oil along shores composed of different sediments, e.g. sand, cobble, pebble, etc.,
5. examine Big Glace Bay Lake and suggest to EPS the best method of cleaning the marsh,
6. extend the coastal study begun in March 1979 to beaches north of Fourchu for the purpose of obtaining more baseline information on the east coast of Cape Breton Island.

CLEANUP OPERATIONS

Two control centres had been established by the Coast Guard to coordinate cleanup operations of the oiled shores, at Low Point (Sydney) and at Mulgrave (Strait of Canso). In all cases the cleanup operations consisted only of manual techniques, i.e. people with rakes and shovels. No mechanical methods or dispersants are known to the authors to have been used to clean the beaches. An estimated 250 people were involved in the Low Point operation and 260 worked out of Mulgrave. This cleanup technique was simple and very effective, but very time consuming. The oil was raked or shovelled by hand from the beach, usually from the upper foreshore, and placed into plastic bags or 45 gallon barrels. The bags were carried to the back of the beach, generally by hand. The barrels were loaded onto front-end loaders which transported them to trucks. Most of the plastic bags remained on the beach for later pick-up, but oil-filled barrels were taken to selected dump sites. Where the front-end loaders or all-terrain vehicles could not reach the cleanup site, a temporary road was ploughed in the backshore or cleared through the brush. These roads constituted the most significant damage to the environment. The effectiveness of the cleanup operation depended primarily on the abundance of oil and the type of shoreline, e.g. rock or sand beach. Cleanup also varied slightly

between work crews, but in general the beaches cleaned were very well done with little or no apparent damage to the beaches.

The location and penetration of the oil and the degree of cleanup can best be discussed for each of the coastal environments examined, namely sand beach, gravel-cobble beaches, marsh and rocky shores or break walls.

The oil coming ashore was Bunker-C6 type, which because of the cold water temperatures had changed to a congealed 'toffee-like' substance. In general on all shores except the steep rocky ones, the oil was deposited across the foreshore as continuous or discontinuous sheets or pans. The oil pans were usually less than a few centimetres thick. However, accumulations of oil were thicker along the shores of Big Glace Bay Lake.

a. Sand beach

Initially the larger sheets and pans of oil were easily raked up from the beach because the oil did not penetrate more than 1 or 2 cm into the beach (Plate 1). In some cases, the oil came ashore as globs less than one or two feet in diameter. Often a bird formed the nucleus for such globs. These were also easily scraped from the beach.

Some of the sand beaches, e.g. at Dominion and Pt. Michaud, were reoiled during successive tides, but in these cases the oil was in the form of small balls of silver-dollar size or less (Plate 20). In most cases, the balls of oil were left on the beach surface but on the more active beaches, e.g. Pt. Michaud, the oil became buried in the migrating cusps alongshore. It was difficult to determine the degree and depth of burial of the oil, but all examples found were not more than 10 cm below the beach surface. Where oil on the beach surface was exposed to the sun it became less viscous and began flowing across the beach face (Plate 3) but penetration of the sands was small, generally less than 1 cm.

The sand beaches represented the easiest type of coastal environment to clean given the Bunker-C type of oil. A brief summary of the amount of oil found on each of the beaches visited on May 2 to 5 is given in Appendix 1.

b. Gravel-cobble beach

Of the coarse sediment beaches visited, the oil was found in heaviest concentrations near the high tide limit. However, scattered stones and cobbles were observed to be oiled along the entire foreshore (Plate 4). The oil was often mixed with thick banks of kelp which accumulates along the upper foreshore. When mixed with the kelp, the removal of oil by rake and shovel was relatively easy but all of the kelp removed. Oil on the gravel and cobbles generally penetrated the first few layers of sediment quite readily and formed a relative surface of gravel in oil. On the south bar near Sydney, the oil was found firm down to 11 cm below the surface. Penetration was stopped when sand was reached (Slide 26) beneath the gravels. To remove this oil it was necessary to also remove the surrounding oiled gravels. In no instance were amounts of sediment removed large enough to affect the normal beach processes and changes.

Many of the large cobble-boulder beaches had not been cleaned because of the difficulty of retrieving the oil from between the boulders. Most of the individual cobbles and boulders oiled will have to be left for natural cleaning by waves and by abrasion with other sediment. The oil was not extensive enough alongshore to form a massive 'pavement' which would prevent normal sediment transfer.

We observed some beaches where a narrow band of hardened oil was deposited along the high tide limit. Such bands probably need to be at least broken up. The most difficult shores to clean are the large boulder beaches and the gravel-cobble storm ridges built up between rock outcrops. Such was the case near Fox Main, Chedabucto Bay, where oil had been deposited above the normal high tide limit between the rock outcrops and onto the gravels between the rock.

c. Rocky Shores

Very few of the rocky shores are accessible by road. The rocky shores examined in Chedabucto Bay were covered by oil in the

intertidal zone. Oil often filled many of the crevices and notches in the rock face. Little attempt had been made to clean these shores because of the extreme difficulty, and probably because of the hope that natural cleaning would suffice in time. However, some of the rocks at Fox Main were still covered by oil from the Arrow tanker spill of 1970 indicating that self-cleaning may occur very slowly indeed.

The main problem with oil on rocky shores is that as the stranded oil warms up in the sun it flows downslope to cover more of the rock surface (Slide 27). This will occur even on cold winter days. Often an oil sheen can then be seen on adjacent waters. While such sheen oil has little environmental effect on the shores from a geomorphological point of view, these are aesthetic damages to the shore, as in places as north Sydney Bar which is a recreational area. Frequently stranded oil acted to form conglomerates with smaller pebbles and boulders (Slide 28).

d. Marshes

The most severely oiled marsh was that in Big Glace Bay Lake. A marsh in Framboise Cove was also oiled badly. Both were examined on May 2 to 5, 1979. The oiling was restricted to the edge of the shores and to small channels through the marsh (Slides 29 and 30). There were few instances where oil reached the grasses above high tide limit (Slides 31,32). One problem was that of oil found lying on the bottom of rivers and channels. This oil is almost impossible to clean up (Slide 33). Rakes and shovels were being used at both marsh areas and it appeared to be the most effective cleanup method, as well as having the least effect on the marsh (Plate 5). Marsh areas in the middle of the bay posed greater logistics problems than cleanup problems. A major problem was that of the removal of bags of oil, debris from the marsh before the incoming high tide In several cases it was observed that many of the bags were piled on top of each other, and had fallen over allowing the oil to seep back onto the beach or marsh. This was a general logistics problem, and was also seen elsewhere (Slide 34).

DISCUSSION

The cleanup operation along the Cape Breton shores was highly effective on sand beaches (Slide 35) and to a lesser extent on the coarser grained beaches. The marshes were also cleaned effectively. Only minor scattered globs of oil (see Appendix 1) remained on most of the cleaned beaches and probably most of these reached shore some time after the cleanup. Some attempt had been made to clean the gravel-cobble beaches, and for the most part all 'pavements' of oil had been broken up and most of the oil removed. The remaining oil is more of an aesthetic problem than an environmental one.

The proportion of oil to sediment and other debris dumped into the plastic bags and barrels decreased considerably after the initial cleanup efforts and after the first beach cleanup. Reoiled beaches often lacked the protective line of kelp to absorb the incoming oil, allowing the oil to spread readily over the beach surfaces. Also, such later accumulations of oil were smaller in amount and were more mixed with the beach sediments (either because of warmer temperatures or waves). As a result less oil was picked up readily, and cleanup became less effective.

Toward the end of the observation period (late May) it became clear that on sandy beaches several factors contributed to burial and incorporation of oil in the sandy sediments. Thus the steep cobble-gravel beaches, common in winter, were becoming infilled at their base by sand between late March and early May, and in many cases the small globs of oil were being buried in the process. Also, on the sand beaches the small oil balls were being coated by sand and were moved alongshore and across slope by the same proceses as normal beach pebbles.

Many of the small inlets along the coast had been boomed either with a tassel or fibre boom or by an inflated type of boom. In both cases, the booms allowed oil to bypass underneath because of the currents. At Framboise oil entered into the inlet because the boom did not extend up the beach slope, stretching only over the water surface. Oil had bypassed the boom during high water and wave conditions, which overwashed the low lying inlet entrance.

Booms were generally effective in stopping some oil from reaching the sheltered marshes.

Baseline information on coastal morphology, sediments and processes is being gathered and analyzed on a reconnaissance basis. Future field studies are planned for early June and mid-summer to examine the changing beach characteristics.

APPENDIX I (Taylor and Frobel)

LIST OF SHORES VISITED MAY 2 to 5, 1979, AND THE OCCURRENCE OF OIL

North Sydney Bar

Gravelly sand spit extending from a boulder-cobble shoreline and ending in concrete breakwater fronted by large concrete blocks - main sand section cleaned - boulders nearshore and break wall uncleaned and covered by oil - sheen in water originating off break wall - some oil buried in sand (5 cm depth) between and near boulders and scattered on shingle storm ridge - small globs (<2 cm width) mark last high water swash on cleaned beach.

South Sydney Bar

Gravel storm ridge, sand and gravel lower foreshore - cleaned - new globs of oil (1' or less in diameter) scattered along high tide limit - oil in sand, no penetration - oil in gravel and kelp seeped up to 11 cm beneath surface - many single cobbles covered by oil - would require further cleaning.

Dominion Beach

Low bluffs to south of long sand beach - cleaned - kelp at bluffs absorbed most of oil - all removed by hand - temporary road cut in base of bluff - may accelerate erosion by waves but no large scale damage to shore - only scattered patches of oil (less than 1' diameter) remain - no further cleaning required unless reoiled.

Big Glace Bay Lake

Narrow inlet and surrounded by marsh - heavily oiled in marsh, very little oil on outer beach - oil just attached to shores and deposited not above high tide limit in grasses - manual raking method is best - areas cleaned are well done and new oil is absorbed by thin bank of old grass which will require further raking - many plastic bags had fallen over and spilled contents - further cleaning required.

Morien Bay

Long spit, mixed sand and gravel - scattered oil in kelp at high time limit - not cleaned by May 4 - waves transporting sediment upslope - may redistribute oil - oil only in minor amounts - easy cleanup by hand.

Mira Beach

Sand beach at entrance to Mira River - cleaned - only scattered small globs (<1' diameter).

Mira Beach North

Just NE of river, with pocket cobble beaches - cleaned - only a few oiled cobbles remain.

Catalogne Beach

Tassel boom at inlet entrance, scattered oil along sand and gravel-cobble beach - cleaned once but may require some further cleaning - oil mostly in kelp along high tide limit - oil along bluffs to east - difficult to clean.

Main-à-Dieu

Cobble-gravel beach, sand in subsurface of beach - many oil patches (<1' diameter) on cobbles - requires some cleanup - oil heated by sun has begun flowing around pebbles - several centimeters penetration.

Gabarus Beach

Cobble storm ridge, fine gravel beach face and exposed bedrock at low tide, only minor oil globs - no cleanup - only quick pickup of oil required.

Marsh of Framboise Cove

Being cleaned May 4, oil along channel banks in marsh, little or no oil above high tide limit in grasses - oil effectively raked up manually.

Framboise Beach

Gravel storm ridge, sand and gravel downslope - cleaned of oil to south of inlet entrance, boom at entrance - washover of kelp and oil into inlet - oil along high tide limit of beach in kelp - only scattered patches of oil in intertidal - no penetration into sands.

Michaud Beach

Extensive sand beach - cleaned - many small oil balls and silver-dollar size oil globs in breaker zone and across beach - most being reworked with sand - many buried up to 10 cm below beach surface - cleanup still continuing on May 4, 1979 - manual rake and shovel operation - bags containing more sand than oil.

CHEDABUCTO BAY

Phillips Harbour

Oiled May 3 or 4 - patches of oil melted and penetrated into gravel at high tide limit, and on boat launches - cleanup planned for May 5.

Fox Main

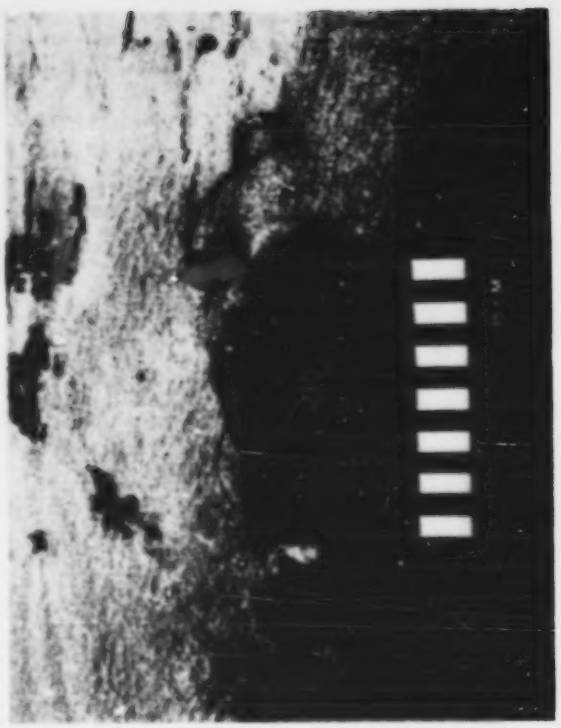
Cobble-gravel beach cleared but oil patches still common - new oil perhaps - oil had penetrated upper few layers of gravel - oil patches less than 3' diameter - oil on rocky headlands, seeped into fractures and onto gravel between rock surfaces - very difficult to clean - oil mostly at rock-gravel beach interface and above high tide limit - old hard tar (presumably from Arrow tanker spill) still covering some rocky headlands - hard 'pavement' forming where oil has covered gravels, most only small area (less than 3' diameter).

Plate 1. Stranded Kurdistan oil overlying sandy beach of South Sydney, Cape Breton Island, May 2, 1979.

Plate 2. Oil plaques on Point Michaud sand beach, May 4, 1979.

Plate 3. Stranded oil staining sandy beach near Framboise, Sape Breton Island, May 4, 1979.

Plate 4. Newly incoming oil stranding on gravel-pebble beach of Phillips Harbor, May 4, 1979.



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1

3

Plate 5. Collected oiled debris in 45 gallon drums along the shore of Big Glace Bay lake.

IV. SINKING OF THE KURDISTAN BOW SECTION: OBSERVER'S COMMENTS

D. McKeown, Atlantic Oceanographic Laboratory

INTRODUCTION

On the morning of March 28, 1979, subsequent to the decision to sink the Kurdistan bow section offshore, the Atlantic Oceanographic Laboratory (AOL) was asked by the BIO Scientific Response Team to place one scientist aboard a vessel to observe the event. His role was to:

(1) note how the scuttling was carried out and observe possible effects of seastate, wave action and other oceanographic factors,

(2) estimate the final location of the bow section on the sea floor, and make observations,

(3) note any oil slicks which might occur during the operation.

The plan was to sink the bow section in 4200 m of water southeast of Halifax by flooding certain tanks of the hull section through appropriate valves. If this failed, it was to be sunk by explosive charges or by gunfire.

EQUIPMENT

Activities of the AOL observer were constrained by (1) the requirement that all equipment had to be delivered to the Coast Guard Base, Dartmouth within 24 hours of notification, and (2) by the fact that the type of ship he would be operating from was not known. With these limitations in mind, it was decided that (a) an attempt would be made to mark the sunken bow section with a mooring line to the surface, (b) to establish descent rate and final location of the bow section acoustically, and (c) to deploy sea surface and sea floor drifters at the disposal site in order to allow preliminary determination of surface and bottom current patterns.

The mooring was to consist of 4900 m of 5 mm polypropylene rope with three inflatable floats and a 'high flyer' as surface markers. The rope would be paid out by hand from a drum on the deck of the support ship. The descent rate would be determined by measuring the time required to pay out a layer of rope at known drum diameter.

Acoustic monitoring of the sinking was to be accomplished with the aid of a 'pinger' affixed to the bow section before scuttling. Signals were to be received aboard the support ship by means of a portable Massa TR57 transducer, a Gifft 12 KHz transceiver and an EPC precision graphic recorder. Figure 1 (a) illustrates the geometry and 1 (b) a simulated graphic record. Depth of bow section and horizontal range from the support ship were to be calculated as follows:

$$S_1 = V^* [t_a - DR^* (T-To)]$$

$$\Delta S = V^* t_b$$

$$Z = D - \frac{2S^* \Delta S + \Delta S^2}{4D}$$

$$X = \sqrt{S_1^2 - Z^2}$$

where $\Delta S = (S_{2A} + S_{2B}) - S_1$

DR = pinger drift rate

To = turn-on time of pinger

T = time of fix

V = mean sound velocity at site (1488 m/sec)

OBSERVATIONS

At 0730 AST, March 31, 1979 the HMCS Margaree departed from Halifax for the scuttling site. On board were Cmdr. R. Luke, Queen's Harbour Master who was in charge of the operation, a team of navy divers who were to scuttle the bow section, news teams from CBS-TV and ATV and one observer each from the Environmental Protection Service (EPS) and the Atlantic Oceanographic Laboratory at the Bedford Institute of Oceanography. The ship's tasks in order of priority were:

(1) scuttle the bow section;

(2) support the TV news teams;

(3) transport one scientific observer each from EPS and AOL to the site.

The divers and the captain of the HMCS Margaree could envision no problems as far as the acoustic work was concerned. However, objections were raised against the deployment of the marker buoy rope from the ship, since it was felt that this would interfere with the needed mobility of the

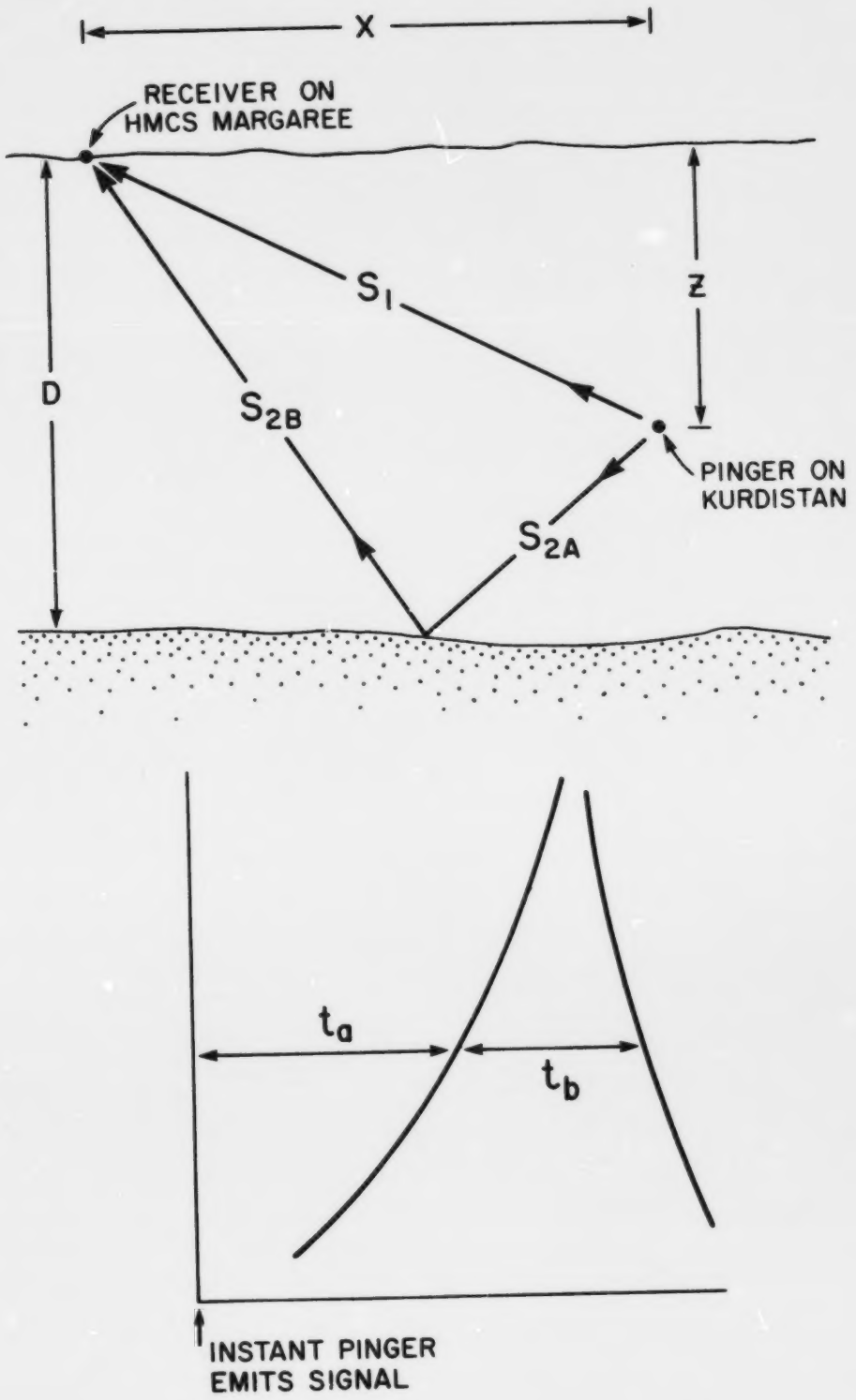

Figure 1. Positioning Kurdistan bow accoustically.

vessel. In the end it was agreed to pay out the marker rope onto the sea surface.

The Margaree was ready to begin operations at the site at 0545Z April 1, 1979. At that time the bow section was secured by tow lines to the CCGS Alert and the tug Point Gilbert and lay at about a 30° bow up attitude. The water depth at the site was about 4200 m. The weather was overcast with light wind, negligible waves and a slight swell (0.5 to 1 m). The plan called for the divers and news teams to be in two ship's boats and two Zodiacs. No space was available for the scientific observers. The divers would go aboard the Kurdistan and after all tank top vents and valves were opened would first attempt so as to bring the hull into a horizontal position. This didn't work. The divers then flooded the number 1 wing tanks and ullage spaces over the cargo in order to complete the scuttling.

Events eventually proceeded as follows:

April 1, 1979

0545 Divers and news teams launched in Zodiacs and in ship's boats.

0800 All tank top valves and vents were opened, and flooding of fore peak tanks commenced (Plate 1).

0830 CCGS Alert and Point Gilbert disconnect two lines.

0900 Marker float and rope paid out onto sea surface from ship's boat. Marker rope attached to line dangling through port bow fairlead of hull section by divers.

0925 All personnel off bow section which is beginning to tilt toward vertical. Divers reported they were unable to flood forepeak. Instead they then flooded number 1 wing tanks. No report of whether or not they succeeded in flooding ullage spaces (Plate 2,3,4).

0940 Bow nearly vertical.

0945 Small quantity (50-100 gallons) rust brown oil pours out of forepeak through hatch. Divers report this is spilled lubricating oil. Forms shiny area 100 to 200 m radius around wreck (Plate 5).

1010 Bow vertical. Waterline about 2 m below 'K' in ship's name. No further signs of oil (Plate 6).

1025 Bow vertical. Waterline at 'K'.

1110 Bow vertical. Waterline at 'R'.

1135 Bow vertical. Not sinking further. It is thought that it is sitting on an air bubble trapped in the forepeak.

1155 Four 3.5" shells fired through bottom of hull to starboard of keel near waterline from approximately 500 m range. Air under significant pressure begins escaping from holes (Plate 7,8).

1210 Stopped sinking again. Bow vertical. Six to eight more shells fired into bottom of hull (Plate 9).

1218 Bow section sank at 41°55.2'N, 60°58.0'W (Plate 10). Fifty seabed and 100 sea surface drifters released from HMCS Margaree.

1330 HMCS Margaree left disposal site to return news teams to Halifax. CCGS Alert to standby 24 hours. Aircraft overflights to occur once per day for first 4 days, and subsequently every seventh day for one month.

April 2, 1979

0400 HMCS Margaree arrived HMC Dockyard, Halifax.

COMMENTS

A few minutes after the bow section sank, a Tracker aircraft flew over the site and flight crew spotted the surface marker of the marker rope. At 1250 the Margaree began a visual search for the buoy but was unable to locate it. Search was terminated unsuccessfully at 1330. It is suspected that the marker floats were pulled under and collapsed. If this operation were to be repeated the marker rope should be paid out from the deck of an attendant vessel as originally planned. If that is not possible, it should be drawn off a reel mounted on an unmanned raft. Under these arrangements this way of marking the hull section would work out effectively. A poor third choice would be to flake the rope out on the surface and attach streamlined sub-surface buoyancy. This unfortunately was the method used in this case.

The acoustic pinger was secured to the starboard anchor chain near the windlass, and was operating properly at that time prior to the sinking of the bow section. At the time the receiving system aboard the Margaree was also receiving noise from other sources such as the ship's screws.

However, no signals were received from the pinger once the bow submerged. One possibility for the failure of the pinger is that it may have been damaged by the gunfire. The Margaree did track the Kurdistan to a slant range of 250 m on their own sonar, but could not establish the descent rate. If this exercise were to be repeated, it is recommended that two pingers be installed on the wreck, and that a second receiving system, such as a deep ocean ultra-short baseline acoustic positioning system be used.

As a final comment, a naval vessel with even minimal scientific investigation as its third priority is an unsuitable platform to work from. Instead an oceanographic vessel with its more flexible approach to carrying out new and unique studies and handling unusual equipment would be a more suitable vehicle to carry marine scientists to such an event.

The question has been raised as to whether there are parallels between the sinking of the Irving Whale barge in 1970 and this recent sinking of the Kurdistan bow. The major difference is perhaps that the Whale sank accidentally at a location of its own choosing in an environmentally sensitive area whereas the Kurdistan bow was purposely sunk at a presumed safe disposal site. The Whale can be examined readily by divers or submersibles (depth 65 m) whereas the Kurdistan is at 4200 m for environmental reasons. The precise location of the Whale is known whereas only the general location of the Kurdistan is known. Existing salvage technology permits recovery of the Whale if desired whereas the Kurdistan bow is probably gone forever.

PLATE LEGENDS

Scuttling sequence of Kurdistan bow section, April 1, 1979.

Plate 1. Work commencing with flooding of bow tanks. Small craft to right of bow section with naval diving personnel. Time 0800 hrs.

Plate 2. All personnel off the hull section, number 1 wing tanks flooded. Time 0925 hrs.

Plate 3. Bow tilting up toward vertical.

Plates 4 - 6. Bow tilting to 90^{o}. Time ca. 0945 hrs.

Plate 7. Bow beginning to sink slowly. Time 1015 hrs.

Plate 8. Four 3.5 inch cannon shells fired into bow section. Time 1155 hrs.

Plate 9. Bow stopped descent. Time 1203 hrs.

Plate 10. More shells (6 to 8) fired into hull section. Time 1207 hrs.

Plate 11. Bow section sinking below surface. Time 1217 hrs.

Plate 1.

Plate 2.

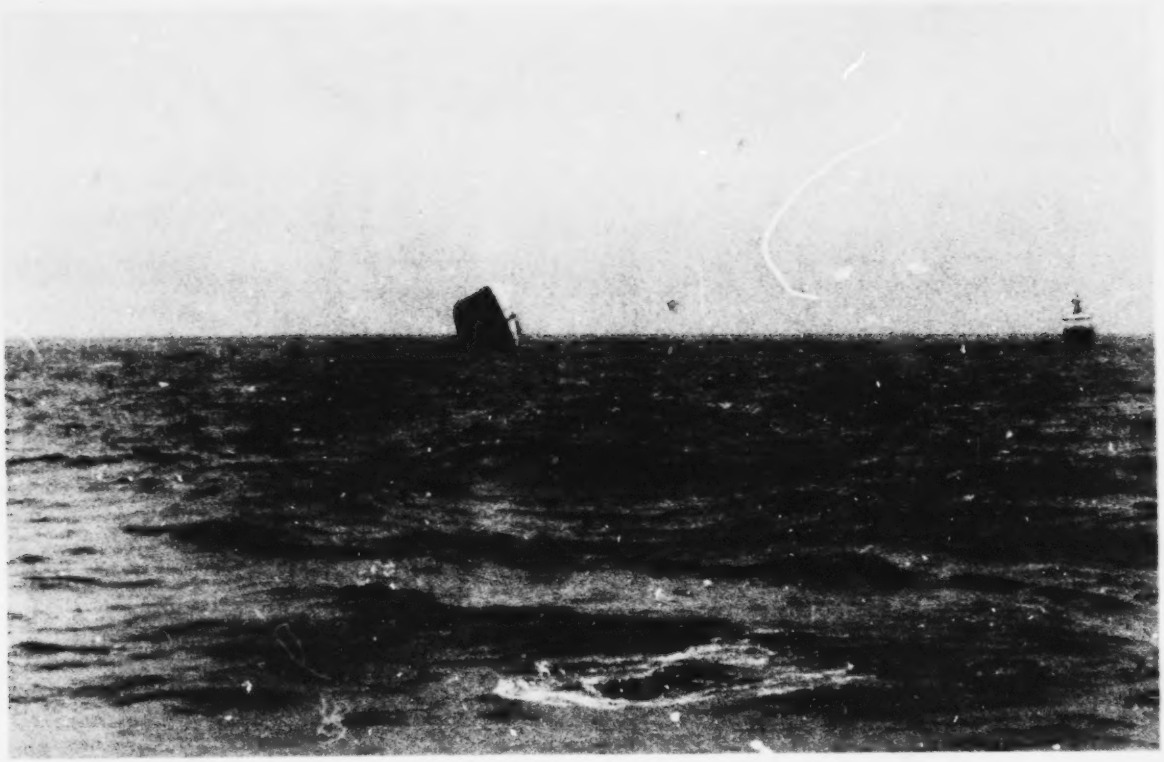

Plate 3.

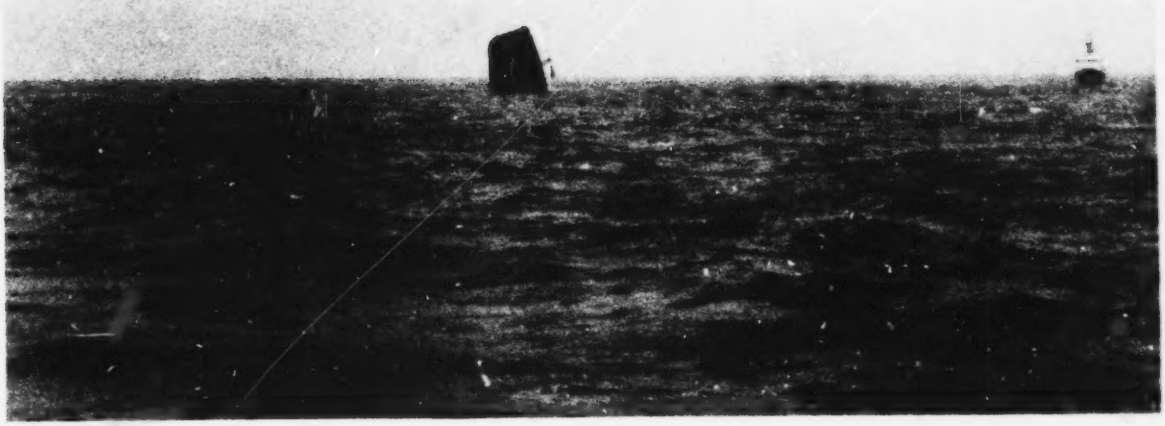

Plate 4.

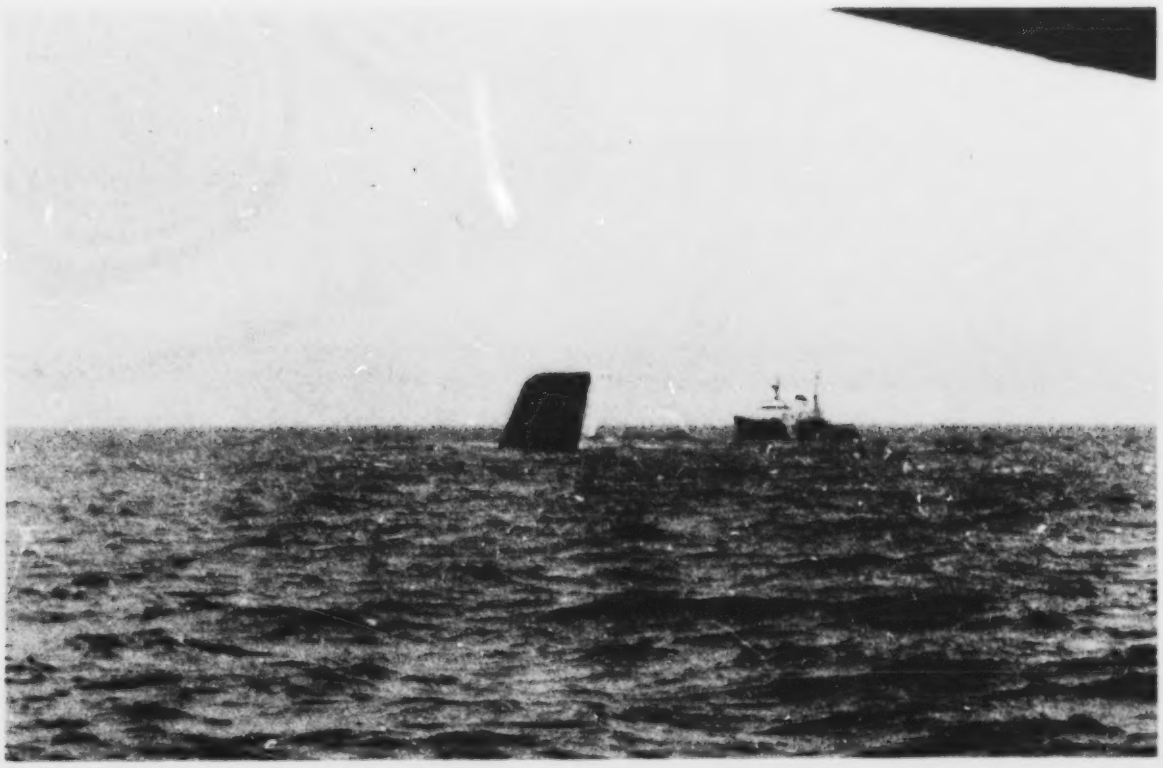

Plate 5.

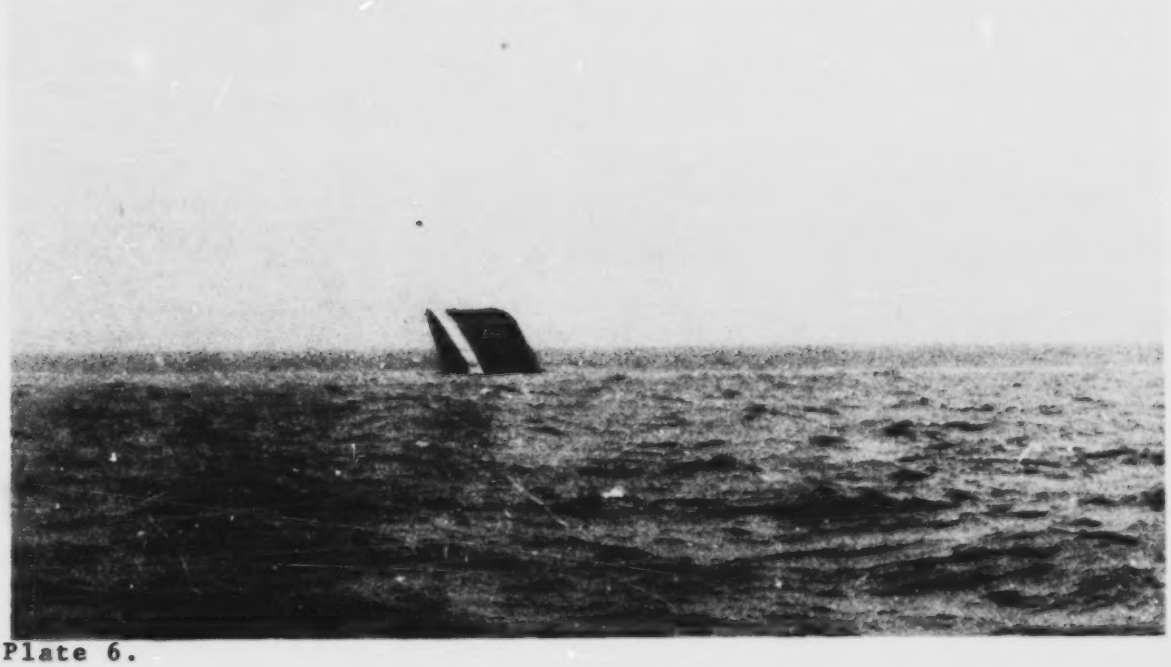

Plate 6.

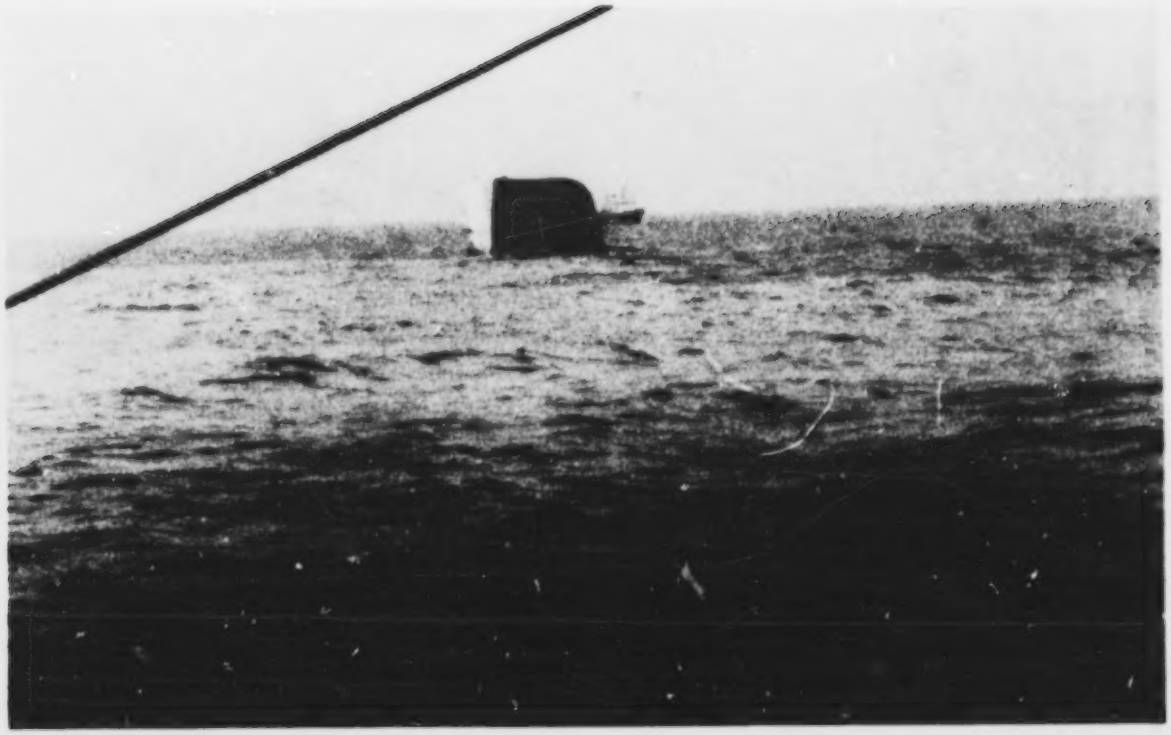

Plate 7.

Plate 8.

Plate 9.

Plate 10.

Plate 11.

V. IMPACT ON SEA BIRDS: PRELIMINARY COMMENTS

R. G. B. Brown

Canadian Wildlife Service, BIO

The Atlantic Region of the Canadian Wildlife Service (CWS) was involved immediately and directly as soon as the breakup of the tanker Kurdistan became known. The Atlantic Region Headquarters in Sackville, N.B. were notified by the Environmental Protection Service (EPS), and as a result I participated in the March 17 overflight of the tanker breakup area. I also attended the various emergency meetings, both within the Bedford Institute of Oceanography, and as part of the more general inter-agency Regional Environmental Emergency Team (REET). Here, the role of CWS was to provide information, where available, on the locations of bird colonies and feeding areas that might affect the course of the Canadian Coast Guard's operations in dealing with the two halves of the tanker.

BIRD IMPACT

Oiling of Seabirds

Initially there appeared to be little impact or effect on seabirds, either in the Sydney Bight area or on the Scotian Shelf. Certainly there was no massive kill as an immediate result of the tanker breakup, except for some lightly oiled birds that came ashore early on, along the Sydney shoreline. These probably came in with oil entrained in the drifting pack-ice as the ice-fields drifted in through Cabot Strait and closed off the entire Sydney Bight area within a few days after the tanker accident. Some may have drifted in alive and died subsequently. Badly oiled birds, incapable of flight, tend to drift at the upwind end of an oil slick.

Some very few oiled birds were also brought into the CWS unit at BIO by the returning crew of the CSS Hudson which had been investigating oil-in-ice reports off the southeast coast of Cape Breton Island (viz. Trites, this report). Again, bird-mortality for that northeast region of the Scotian Shelf was unexpectedly low, immediately after the tanker breakup. In this respect the accident was totally unlike the 1970 Arrow incident, during which large numbers of badly oiled birds came ashore continuously and almost immediately following the ship's grounding.

These first impressions, of low bird mortality immediately following the tanker breakup, were confirmed by Dr. A. R. Lock of our CWS Seabird Research Unit, who carried out shoreline surveys in Cape Breton Island and also found no evidence of oiling of birds in the first week after the accident. There was one conflicting report of badly oiled dovekies coming ashore on Sable Island circa March 20, three days after the spill. On further investigation, however, it was concluded that these birds were probably oiled as a result of illegal tanker washing or bilge pumping, a not uncommon incident in these waters. The birds were too badly oiled to have flown the distance from Cabot Strait to Sable Island (viz. location map p. 0, this report), and it would have been impossible for them to have drifted the distance in a Kurdistan oil slick. Later, 'fingerprinting' of the oil samples taken from these birds (E. C. Levy, BIO) indicated the oil not to be from Kurdistan's cargo.

The heavy impact on the Scotian Shelf seabird population was not apparent until after April 1, when seabirds and large amounts of oil began to strand on the shore of Cape Breton Island; first around the southeast coast between Pt. Michaud and Gabarus (April 9-10), and then on Cape

Breton's north-coast between Scatarie Island and Sydney (April 13-15). Personnel from the CWS Atlantic Region Headquarters (A. D. Smith and B. C. Johnson) participated in beach counts of dead birds during this part of the Kurdistan operation (Plates 1-7).

Seabirds Mortalities

Attempts at estimating bird mortalities during the Kurdistan operation were frustrated by several factors, including the disappearance of the spilled oil slick between March 16 and April 9. It is likely that many seabirds were killed during this period, at sea, because dead oiled birds will sink after approximately 10 days. Any estimate of mortality will be much too low for that reason. Moreover, during the shoreline cleanup operations, little attempt was made by the cleanup crews to separate, count and identify stranded oiled birds from the rest of the oiled shoreline debris. The beach counts were thus at best low approximations of the real number of oiled seabirds that died as the result of this tanker accident.

GENERAL COMMENT

In retrospect the Kurdistan was an unusual tanker accident. Unlike the Arrow incident, which occurred in similar weather under similar conditions in roughly the same area, the Kurdistan spill did not result in immediate bird mortalities. The impact was delayed until the arrival of the oil slick onto the Cape Breton Island shorelines four weeks later.

Mortality estimates are low and inaccurate because of (1) the length of time the oil remained at sea, (2) the lack of bird kill counts during the cleanup operation, and (3) general inaccessibility of much of the Cape Breton and Guysborough County shoreline.

The incident also pointed out the need to be properly aware of the environmental hazards associated with a spill. In the end the lost oil slick proved to be far more damaging environmentally than the intact cargoes of oil that remained in the two halves of the tanker: the towable stern section, and the untowable bow section which was later sunk off the Scotian Shelf south of Sable Island. Yet most of the attention and effort expended was directed to the two tanker halves. The missing 7,000 tons of Bunker C was put out of mind until it reappeared four weeks later, after the operation had apparently been brought to a successful conclusion.

Plate 1. Beach collecting of oiled seabirds from stranded oil, Point Edward, Cape Breton Island.

Plate 2. Seabirds entrained in freshly stranded Kurdistan oil, Glace Bay sanctuary, Cape Breton Island. Oiled birds frequently drift in the rear edge of oil slicks.

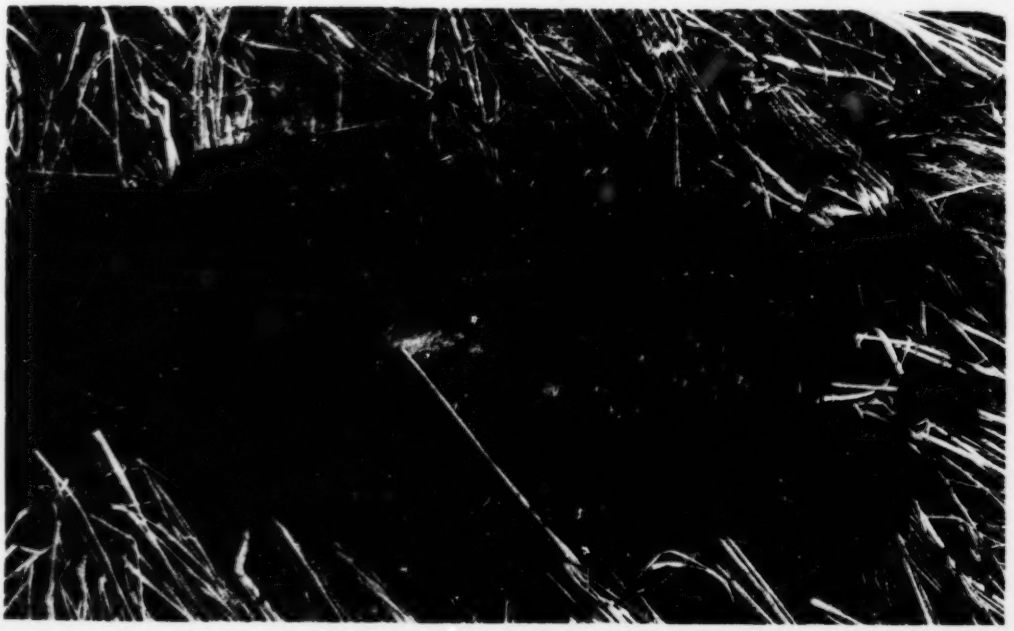

Plate 3. Oiled seabird, Glace Bay sanctuary, Cape Breton Island.

Plate 4. Oiled seabirds in a freshly stranded oil slick, Low Point, Cape Breton Island. Seabirds often form the nucleus of an oil plaque.

Plate 5. Dead oiled murre, Low Point, Cape Breton Island.

Plate 6. Living oiled murre found on rocky shore, Low Point, Cape Breton Island.

APPENDIX I. CHRONOLOGY OF EVENTS FOLLOWING KURDISTAN BREAKUP MARCH 15 to MAY 31, 1979

APPENDIX I.

CHRONOLOGY OF EVENTS, MARCH 15 to MAY 31, 1979

The following is an account of events surrounding the breakup of the tanker Kurdistan, the disposal of the two tanker sections, and including the activities of personnel of the Bedford Institute of Oceanography in association with various other Canadian government organizations (DND, MOT, EPS, FM/DFO, CWS, AES)[1].

The account was compiled using Canadian Coast Guard and Environmental Protection Service files, and internal Bedford Institute of Oceanography files. The items annotated with an asterisk (*) indicate BIO activities specifically.

March 15, 1979 — The British tanker Kurdistan, carrying ca. 30,000 tons Bunker C fuel oil[2], is en route from Cape Breton, N.S. to Sept Iles, Quebec, when she encounters heavy ice in the Cabot Strait. She returns to open water near position 4655.8N and 5939.7W.

At 1756Z hrs the vessel reports losing oil.

At 1853Z the vessel advises that her number 3 port and starboard wing tanks are cracked, a 6 ft gash in the port side and a 6 inch gash in the starboard tank.

At 1924Z the external leaking seems to have stopped, but there is concern over a continuing drop in oil level.

20152 - the cutter

CCG 'Sir William Alexander' proceeds to Cabot Strait.

2121Z - Kurdistan master radios no need for immediate assistance.

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1 DND=Department of National Defense; MOT=Ministry of Transport; EPS=Environmental Protection Services (Department of Environment); FM/DFO=Fisheries Management of Department of Fisheries and Oceans; CWS=Canadian Wildlife Services (Department of Environment); AES=Atmospheric Environment Services (Department of Environment).

March 16, 1979 0018Z - despite no signs of further deterioration, leaking is increasing.

0134-0135Z - Master interrups radio=telephone conversation with CCG with statement that ship is breaking up. SOS calls sent out.

The Kurdistan bow and stern sections drifting in Cabot Strait, with the stern section at position 4633.5N 5917.5W. The bow section is drifting nearby at the same rate and direction.

At 1200Z the Sir William Alexander is standing by the stern section. The bow section is about 2.6 miles from the stern, and there is no apparent oil leakage.

CCGS 'Wolfe' proceeds to Cabot Strait. The 'Sir William Alexander' takes aboard the survivors from the Kurdistan, including 3 women and 2 children.

1400Z. Stern section is under tow by tug.

CCG is on scene with helicopters and containment and clean-up equipment. EPS establishes an Environmental

* Emergencies Team, including representatives from BIO, AES and FM. A BIO Scientific Response Team is designated to participate in EPS/CCG response plan[1].

DND arranges first over-flight of the Kurdistan and Cabot Strait.

* Member of BIO Scientific Response Team participates in EPS overflight of the Cabot Strait (viz. Neu, this report).

* BIO Scientific Response Team participates in first of daily Kurdistan Environmental Emergencies Team meetings, providing scientific information on currents, drift trajectories and spill prediction.

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[1] Bedford Institute of Oceanography (BIO) consists of three main government laboratories - Atlantic Geoscience Centre (AGC), Atlantic Oceanographic Laboratory (AOL), Marine Ecology Laboratory (MEL). There are in addition a number of other government laboratories located on the premises, including CWS.

March 17, 1979 * BIO overflight of Cabot Strait, Kurdistan and Cape Breton, organized by AGC member of Scientific Response Team. Overflight includes extensive photography by BIO photographer of Cape Breton coastline in preparation for shoreline sensitivity mapping (viz. Reinson, this report.

Stern and bow sections are under tow, and drifting down the Laurentian Channel toward the Atlantic Ocean. The stern section contains 17,000 tons of Bunker C fuel oil. Its heating system is found to be intact. The bow section contains 7,200 tons of fuel oil, but has no functioning heating system for the cargo.
Strong north and northwest winds (30 knots), with rough seas. Temperature -7°C. Snow flurries.
Monitoring by aircraft and Coast Guard vessels indicates no apparent leakage of oil from the vessel sections.

* BIO Scientific Response Team meets with EPS Environmental Emergencies Team. BIO provides updated drift trajectories for stern and bow sections.
Kurdistan bow section is ordered sunk at a site off the continental shelf, east of Nova Scotia.

March 18, 1979 Gale force winds, and weather is deteriorating. Stern and bow sections are continued under tow down the Laurentian Channel. The CCG ships 'Sir William Alexander', 'Wolfe', 'Alert' and 'Edward Cornwallis' are all in the area, in addition to three towing tugs.
Most of the Cabot Strait is ice-covered, with the ice field moving southerly and south-easterly towards Cape Breton.

March 19, 1979 Weather conditions are deteriorating constantly, with gale force winds, rough seas and swell, snow flurries, and below zero temperatures. Winds changing to south-easterlies, causing problems for the tugs. These are now

having difficulty maintaining an easterly heading down the Laurentian Channel.

* BIO Scientific Response Team provides drift information regarding the stern and bow sections to the EPS Environmental Emergencies Team, and advises on sensitivity of coastline and suitable lightering ports for the stern section.

March 20, 1979 Bow section drifting in south-westerly direction under influence of east north-easterly winds (30 knots, gusting to 40). The tug towing the bow section is only maintaining contact with the bow, and is not applying a strain on the tow line.

0900Z - the bow section is in the middle of the Laurentian Channel, while the stern section is nearing Misaine Bank on the Scotian Shelf.

* BIO Scientific Response Team meets with EPS Environmental Emergencies Team and CCG representatives, and provides information on currents, and drift prediction. BIO Team members review salvors proposal for the stern section of the Kurdistan.

March 21, 1979 Bow section drifting near Misaine Bank, Scotian Shelf. Stern section is in tow near the edge of the Scotian Shelf, off the Laurentian Channel. Winds are northeast or northeast by north at 35 knots, gusting to 40 knots.

* BIO scientists meet with EPS Environmental Emergencies Team to review drift behavior of the Kurdistan bow section, and provides environmental sensitivity assessment of spills originating on the Scotian Shelf.
* BIO (AGC) shoreline sensitivity mapping of the Cape Breton Coastline is in progress.

March 22, 1979 Continued difficulties in establishing proper tow of the Kurdistan bow section, due to bad weather. Bow section angle of floating is presenting problems in towing, since

a considerable portion of the hull is hanging at an angle below the sea-surface. Stern section, on the other hand, is drifting at a near normal angle, and its drift can be controlled.

Stern section is still under tow, and being held off Cape Breton in open water on the Scotian Shelf. She will be taken into Port Hawkesbury, Chedabucto Bay, for berthing and off-loading of the Bunker C cargo, but Chedabucto Bay is completely congested with first-year ice at present.

First reports of considerable to large amounts of oil contained in an ice-field offshore from the east coast of Cape Breton, near Fourchu Head.

* The BIO research vessel 'Hudson' is in the area on return from a fisheries survey, and is alerted for possible oceanographic studies off Cape Breton.
* BIO scientific staff establish contact with C-CORE (Memorial University, Newfoundland) and CWS (Sackville, N.B.) personnel.
* BIO Response Team meets with EPS and CCG for further discussions on bow section trajectory and potential spill impact on Nova Scotia shores.
* BIO AGC shoreline group moves to Cape Breton to initiate shoreline studies, aerial reconnaissance and assist/advice the EPS environmental Emergencies Team in their shoreline cleanup activities.

March 23, 1979

* BIO overflight of the oil-in-ice area off Fourchu Head (viz. Vandermeulen, this report).
* BIO scientist and chemical oceanography team join the 'Hudson' for studies of the oiled ice area (viz. Trites, this report).
* BIO Response Team discusses oil reports with FM, CWS and EPS. Provides analysis of current and wind data for the offshore Cape Breton Scotian Shelf area.

First reports of oil and oiled birds from Sable Island (viz. Brown, this report). Stern section is being towed into Chedabucto Bay by two tugs, escorted by the 'Sir William Alexander', 'Louis St. Laurent' and 'Edward Cornwallis'. At 2330Z the stern section of the Kurdistan is berthed in the Strait of Canso near Port Hawkesbury.

March 24, 1979

In response to scattered oil sightings over the Scotian Shelf the CCG broadcasts an oil-sighting notice to all shipping crossing Misaine, Banquereau and Emerald Banks.

* BIO helicopter overflight of Cape Breton east coast and offshore ice-fields for oil-in-ice reconnaissance and field studies.
* BIO Response Team meetings with EPS and CCG continue with discussions on projected drift trajectories of the bow section.

March 25, 1979

Bow section in tow, located west of Sable Island on a line between Sable Island and Halifax. Winds in the area of the bow section are swinging to the SE at 35 knots, gusting to 40 knots. The bow section is in tow by the CCGS 'Alert', which will try to ride out of the storm.

* C-CORE scientists are aboard the BIO research vessel 'Hudson' for discussion of oil-in-ice observations.

Continuing reports of oil slicks from the east half of the Scotian Shelf.

Members of BIO Response Team meet with EPS to prepare bow section tow trajectory to take the bow section off the Scotian Shelf to the designated dump-site on the Shelf break once the storm lets up.

March 26, 1979

The tow line from the CCGS 'Alert' to the bow section has parted, and the bow section is drifting uncontrolled southwest of Sable Island in a northwesterly direction.

* BIO 'Hudson' is completing its cruise schedule, and is taking water-column samples between Cape Canso and

Halifax.

* BIO Response Team meets with EPS and CCG personnel to plot out projected drift of the derelict bow section. BIO staff also are involved in analyzing drift patterns of Kurdistan oil from the oil sighting reports.

March 27, 1979 — Bow section has drifted about 16.2 miles with a northerly set. Apparently the wind strength has overcome the current field in the area.

* BIO Response Team provides trajectory predictions for the following 48-hours for the bow section.

March 28, 1979 — 1300Z - the bow section is drifting continuously northeasterly at approximately 1 knot per hour. It is approximately 65 nm WSW of Sable Island and 75 nm S of Nova Scotia mainland. Efforts to get another towline on board the bow section are now underway.

* BIO Response Team is arranging for pinger and tracking devices to attach to the bow section, prior to its sinking at the designated dump-site. BIO notified of space for one BIO scientific observer aboard the DND vessel.

March 29, 1979 — 1730Z - bow section, in tow by the tug Pt. Gilbert and CCGS 'Alert', is heading for the designated disposal site, about 90 nm distant. Expected sinking time sometime Sunday.

March 31, 1979 * BIO observer departs Halifax for the designated dumpsite aboard HMCS 'Margaree' (viz. McKeown, this report).

April 1, 1979 — 1618Z - The bow section is sunk at position 4155.2N, 6058.0W in about 2245 fathoms depth on the Shelf Break.

April 6, 1979 — Tracker reports a large oil slick on the Scotian Shelf, north east of Sable Island.

April 7-10, 1979 Continuous oil sighting reports are coming from Guysborough County (Nova Scotia mainland) and from Cape Breton, Point Michaud to Fourchu area. Also oilsightings are reported offshore from Gabarus, Cape Breton.

April 11-12, 1979 Continuing oilsightings are coming in from Guysborough Co and from offshore Cape Breton. Flint Island is oiled on April 11.

April 13-
May 1, 1979 Continuous heavy oiling of the Sydney-Mira Bay area of Cape Breton, beginning with heavy oiling during April 13 and 14.

* BIO AGC scientific staff assessing cleanup activities in Cape Breton (viz. Taylor and Frobel, this report).

May 1979

* Fisheries vessel 'J.L. Hart' is condusting an oil survey and sampling cruise of inshore water of Guysborough Co and Cape Breton. BIO scientific personnel are aboard to carry out the sampling, for later analysis at BIO. Team from Fisheries is going up to Cape Breton to examine potential pollution of biota.
* Joint BIO/CCG program to monitor the Scotian Shelf for hydrocarbons is being organized, in collaboration with Fisheries Management.
* Continued sampling cruises over the Scotian Shelf, including the CCGS 'Alert' and the Fisheries vessel 'Lady Hammond'. Scientific investigations and analysis supervised by BIO scientists.
* Long-term current monitoring program is initiated for the Scotian Shelf by a BIO ocean-studies group, using satellite tracking, drift buoys and drifter cards.

APPENDIX II.

WIND AND SEASTATE DATA, MARCH 15 TO APRIL 13, 1979 SCOTIAN SHELF AND CABOT STRAIT INCLUDING CRUISE TRACKS FOR KURDISTAN BOW AND STERN SECTIONS.

EXPLANATION OF TABLE

Wind data and seastate (sea and swell) information were extracted from Canadian Coast Guard telexes (CCG Traffic Centre Maritimes).

(1) Times given are Zulu.

(2) Asterisk marked entries* are those from vessels other than the Kurdistan bow or stern sections traversing these waters for the period March 15 to April 1.

(3) Sea and swell ranking are those used in the Admiralty Weather Manual, with mean wave height equivalents (in the open sea) as follows:

Sea/Swell	Mean Wave Height (feet)
Calm	no waves
Slight	5
Moderate	9
Rough	14
Very Rough	19
Heavy	25
Very Heavy	31-37

Wind and seastate data, March 15 to April 13, 1979, Scotian Shelf and Cabot Strait.

Date[1] [2]	Reporting Vessel	Latitude & Longitude		Wind	Temp. °C	Baro.	Sea State[3] Sea	General Comments Swell
March 15/1756	Kurdistan	4655.8N	5939.7W	SSE 20				
1935		4655 W	5937W	SSE 20				heavy SE
2040	Kurdistan	4655.8N	5939.7W	SSE 20			open water	very heavy SE swell
2048Z	Kurdistan	4651N	5930W					
March 16/0134	Kurdistan break-up	4644.48N	5939.42W					
1200	Stern	4633.5N	5918W	NW 25	-5	1019	moderate	moderate
	Bow	155° 2.6 mi from Stern location.						
1200*		4730N	5940.5W	WxN 15			open water	
1625*		4706N	5904.5W	W 25	-7	1022	ice: 7/10 FY,	3/10 grey white
1828	Stern	4634N	5914W					
	Bow	173° 3.6 mi from Stern						
2021*		4623.5N	5945W	NWxN 15	(5°F)	1023	ice free, mod. NW	mod. NW
2020*		4635.6N	5911.6W	NW 15	-3.3		open water, mod.	mod. to heavy
March 17/0000*		4454N	6137W	NE 15/20	-4			
0030*		4627.7N	5910W	NW 15	-6.7	1025	light	light
0400*		4516N	6036N	N 25	-7		moderate	moderate
0405*		4627.9N	5907.9W	NW 20	-10	1024	light	light
0800		4625.7N	5859.3W	N 15	-6.7		light	light
0800*		4549N	5949W	NNW 20			slight	slight
0800*		4624.5N	5937W	WNW 20	-10	1026	ice condition/323	ESE
1155	Bow	4624.5N	5901W	NNW 25	-6		ice edge in sight	
	Stern	4614N	5848W	NWxN 25			ice edge 4627N 5853W to 4634N 5911W	
1200*		4613N	5847W	NW 30	-7	1023	moderate	moderate
1600	Bow	4620N	5847.9W	NWxN 25/30	-6	1019	rough	light to moderate
1600*		4609N	5846W	NNW 30/35				
1600*		4611N	5844W	NWxN 30	-5	1020	open water	
1700	Stern	4604.2N	5841.6W	NWxN 35/40				
	Bow	4619.8N	5847W	NWxW 30		1018	year ice, rough	light to moderate
1800		4626N	5848W	NWxW 30		1018	rough	light to moderate
1800Z	Bow	4619N	5846W	NWxW 30				

Date[1] [2]	Reporting Vessel	Latitude & Longitude		Wind	Temp. °C	Baro.	Sea State[3] Sea	Swell	General Comments
March 17/	Stern	4062.2N	5839W	NW 35/40					
1900Z	Bow	4618.5N	5844.6W	NWxW 35			rough	moderate	
2000Z	Bow	4616.5N	5842.5W	NW 40			rough	moderate to heavy	
	Stern	4558N	5832.5W	NWxN 35/40					
2000Z*		Mira Bay		NW 30/35					
2100Z*		4617N	5843W	NW 35/40			rough	heavy	
	Bow	4616.8N	5843.8W	NW 40					
	Stern	4555.5N	5829W	NW 40					
2200Z	Stern	4554.5N	5827W						
	Bow	4615.2N	5843.4W	NW 40					
2300Z	Stern	4552.8N	5824.6W	NW 25/35					
	Bow	4613.6N	5842.4W	NW 40					
March 18/0000Z	Stern	4551.2N	5821.7W	NW 25/35	-5	1011.5	rough	heavy	
	Bow	4612N	5831W	NWxW 35/40	-5/-6		rough	moderate	
0000Z		4810N	6209W	NNW 35	-6	30.05	very close packed first year ice extending from 10 miles east of Cap des Rosiers 12 miles east of Birch Point.		
0000	CCG Alert	4559.5N	5940W	NW 10	-7		"Ice visible Flint I. to Scatarie. It is practical for this vessel to enter Sydney or North Sydney due ice congestion increasing and potential ice damage."		
0100	Bow	4610.4N	5840W	NWxW 35/40					
0200Z	Bow	4609.6N	5839W	NWxW 35/40					
	Stern	4547.8N	5816.2W	W 25					
0300Z	Bow	4608.6N	5837.9W	WNW 30/35			rough	moderate	
	Stern	4546.7N	5821W	W 13					
0400Z	Stern	4545.8N	5808.2W	WxN 18	-5	1013			
0500Z	Bow								
	Stern								
0600Z	Stern	4544N	5801W	W 12					
	Bow	4608N	5835.5W	W 10					
0700Z	Stern	4544N	5759.2W	W 10					
	Bow	4607.8N	5835.3W	light					
0800Z	CCG Alert	4559.6N	5945.8W	WSW 10/15					
	Stern	4544.6N	5756.5W	Variable 10					

Date[1] [2]	Reporting Vessel	Latitude & Longitude		Wind	Temp. °C	Baro.	Sea State[3] Sea	General Comments Swell
March 18/0800Z	Bow	4607.7N	5833.5W	light				
0900Z	Bow	4607N	5832.5W	light				
1000Z	Bow	4607.5N	5831.5W	light				
*		4542.7N	5750.7W	variable 10				
1100Z	Stern	4542.1N	5748.5W	NW 10				
	Bow	4607.8N	5830.7W	light				
1200Z	CCG Alert	4630N	5917W		-4		Smooth strings of ice miles SE Scatarie.	extending 10/15
	Bow	4607.7N	5830.5W	N11		1018	slight	low
	Stern	4542.8N	5744.8W	NW 10/15	-4	1016		slight to moderate
1300Z	Stern	4540.9N	5741.9W	NWxN 11			slight	moderate
*		4537.5N	6012.5W	N light	-6		sea temp -0.7	
	Bow	4607.1N	5829W	N 11			slight	low
1400Z	Stern	4541.3N	5739.3W	NW 14	-4	1013.5	slight	moderate
1500Z	Stern	4540.8N	5737.6W	NWxW 15	-3	1014	slight	moderate
	Bow	4606N	5828W	N modified				slight
1600Z*		4553.6N	5910.6W	WNW 15	-5			
*		4610.8N	5907W	NW 15	-4.4			
	Stern	4538.8N	5734.8W	NW 10	-2	1013	slight	moderate
1700Z	Bow	4607N	5827W	N 15				moderate
	Stern	4537N	5732.1W	NW 15	-2	1011.5	slight	slight
1830Z	Bow	4606N	5823.5W	NW 25			moderate	moderate
1800Z	Stern	4535.7N	5729.2W	NWxW 10	-3	1011	slight	moderate
1900Z	Stern	4533.9N	5726.2W	NWxW 17	-3	1010.5	slight	moderate
	Bow	4605.5N	5821.7W	NW 25	-3		moderate	moderate
*		4540N	5758W	NNW 20	-3			
2000Z	Bow	4605N	5820W	NW 20	-2		moderate	moderate
*		4535N	5728W	WxN 15/20				
	Stern	4532.6N	5723W	NWxW 20			slight	moderate
*		4611N	5943.2W	NW 15	-0.6		ice 5/10 1st yr, 4/10 grey white.	moderate
2100Z	Bow	4604.8N	5819.3W	NW 10/15	-1			
	Stern	4531.3N	5721W	W 17			slight	slight

Date[1] [2]	Reporting Vessel	Latitude & Longitude		Wind	Temp. °C	Baro.	Sea State[3] Sea	General Comments Swell
March 18/2200Z	Bow	4604.3N	5819.1W	NNW 05	-1		slight	moderate
	Stern	4530.6N	5718.6W	WxN 17			slight	slight
2300Z	Bow	4603.5N	5818.5W	NE 10	-1		slight	slight
	Stern	4530N	5716.3W	NW 15	-1	1008		
2400Z	Bow	4602.7N	5818.7W	NE 13	0		light	moderate
2400Z	Stern	4528.7N	5713.2W	NW 11	-1	1008	slight	moderate
March 19/0000Z*		4608.2N	5941.6W	NW 20	1.1		ice: 5/10 FY, 4/10 GW	
0100Z	Bow	4602.2N	5818.2W	NNE 10	0		light	moderate
	Stern	4527.2N	5710.3W	NW 11	-1	1008	slight	slight
0200Z	Bow	4601.5N	5818W	NNE 10/15	0		slight	moderate
	Stern	4526.2N	5708.2W	light	-1	1007.5	slight	slight
0300Z	Stern	4525N	5706.8W	WxN 10	-1	1007	slight	slight
	Bow	4601.2N	5818.1W	NNE 15/20	0		slight	moderate
0400	Bow	4600.5N	5818.1W	NE 20/25	0			
		course 168°T, 0.6K						
0500	Bow	4559.5N	5818W	NNE 30	1		moderate	moderate
0500*		4527N	5711W	NNE 13				
	Stern	4526N	5709.5W	light	0	1006	slight	slight
0600	Bow	4558.5N	5818.5W	NNE 20/25	0		rough	moderate
	Stern	4529N	5713.8W	NNE 12	1		slight	slight
0700	Stern	4529.2N	5714.6N	NxE 12	1	1004	slight	slight
	Bow	4558.4N	5819W	NNE 20/25	1		rough	moderate
0800	Stern	4529.5N	5714.8W	NE 18	0	1003	slight	moderate
	Bow	4558N	5817.8W	NNE 20/25	1		rough	moderate
		Course 175°T, 0.6K						
0900	Bow	4557.4N	5817.1W	N 25/30	0		rough	moderate
	Stern	4529.2N	5714.8W	N 23	0	1002		moderate N'ly
1000	Stern	4529.8N	5717.2W	N 25	0	1002	moderate N'ly	moderate N'ly
1000	Bow	4556.1N	5817W	N 25/30	0		rough, NE'ly	rough, NE'ly
1100	Bow	4554.5N	5815.5W	N 40	0		rough	rough
	Stern	4529.8N	5720W	N 20/30	1	1002	moderate N'ly	moderate N'ly
1200	Bow	4551.3N	5817W	N 35/40	0		rough	rough
		Course 174, 1.7K						

Date[1] [2]	Reporting Vessel	Latitude & Longitude		Wind	Temp. °C	Baro.	Sea State[3] Sea	General Comments Swell
March 19/1200*		4526.7N	5720W	N 20	1	1001	moderate	moderate
1200*		4547.1N	5939.8W	N 30	0	1030		
1300	Stern	4531.4N	5722W	NNW 23	1	1000	moderate	moderate
1300	Bow	4551.1N	5815.7W	N 30	0		rough	heavy
1400	Bow	4548.9N	5815.8W	N 30/35	0		rough	heavy
	Stern	4533.5N	5723.7W	N 14	1	998		
1400*		4509N	5854W	N 30			no ice from 4500N 5902W	
		Course 031, 10-11K						
1400	Stern	4532.3N	5722.6W	NxW 23	1	999	moderate	moderate
1500	Stern	4533.5N	5723.7W	N 14	1	998		
	Bow	4547.4N	5816.2W	NNW 30/35	1		rough	heavy
1600*		4531N	5839W	NNW 30/35	0		no ice sighted	
1600	Stern	4535.4N	5724.5W	N 20	1	999	moderate	moderate
	Bow	4546.9N	5817.5W	N 20/25	1		rough	heavy
		Course 196, 1.1K						
1600*		Louisbourg wharf		NxW 35/40	0			
1700	Stern	4537.9N	5725.5W	ExW 20	2	999	confused	moderate NE'ly
1800	Bow	4543.5N	5817.7W	E 20/25	3		moderate/no ice	moderate
	Stern	4540N	5725.3W	E 25	1	1000	confused	moderate NE'ly
1900	Stern	4541.2N	5725.6W	ExS 25/30	1	1002	confused	moderate to heavy NE'ly
	Bow	4543N	5818.6W	E 25	1		rough	heavy
2000	Bow	4542.1N	5820.2W	E 20/30	1		rough	heavy
		Course 220°T/1.2K						
	Stern	4542.5N	5726.2W	ExS 30	1	1004	confused	moderate - rough NE'ly
2000*		Louisbourg wharf		NE 25/30				
2000*		4541N	5818W	E 25/30			moderate	rough
2100	Stern	4544.3N	5728W	ExN 30/40	1	1001	confused	moderate to heavy
	Bow	4541.7N	5822.2W	E 30	0		rough	heavy
2200	Bow	4541.2N	5823.5W	E 25/30	1		rough	rough
	Stern	4545N	5727.5W	E 25	1	1007	confused	moderate to heavy

Date[1] [2]	Reporting Vessel	Latitude & Longitude	Wind	Temp. °C	Baro.	Sea State[3] Sea	General Comments Swell
March 19/2300	Bow	4540.9N 5824.5W	E 15-20	0		rough	rough
	Stern	4547N 5728.8W	NE 18	1	1008		
2400	Bow	4540N 5826W (Course 240/1.1K)	ENE 15/20	-1		moderate	moderate
March 20/0000	Stern	4548.3N 5729W	NExN 20/25	1	1007.5	moderate	NE'ly
0000*		4539N 5823.5W	NExE 20	0		moderate	moderate
0020*		Louisbourg wharf	ExN 15	1.1			
0100	Bow	4538.8N 5826.2W	NE 15/20	1		moderate	moderate
	Stern	4550N 5729W	NxE 15	1	1007.5	slight	moderate NE'ly
0200	Bow	4539.2N 5827.4W	NE 15/20	1		moderate	moderate
	Stern	4551.6N 5730W	NExN 20	1	1006	slight	slight
0300Z	Stern	4553N 5730W	NE 20	1	1007	slight	slight
	Bow	4537.9N 5828.2W	NE 15/20	1		moderate	moderate
0400	Bow	4536.8N 5828.5W Course 200°T/1K	NE 15/20	0		moderate	moderate
	Stern	4554N 5729W	NExE 25	1	1004		
0400*		4538N 5826W	NE 15/20	0		moderate	moderate
0500	Bow	4535.5N 5829W	NNE 15/20	0		moderate	moderate
0500*		4535.5N 5827.8W (drift 1.1 nm/178°T)	NE 20	0	1003	moderate	moderate
	Stern	4555N 5731.5W	NExE 20	1	1002	slight	moderate
0600*		4534.3N 5827.6W (drift 1 nm/182°T)	NNE 15/20	0	1001.5	moderate	moderate
0600	Stern		NE 23	1	1002	light	moderate NE
	Bow	4534N 5825.5W	NNE 15/20	0		moderate	moderate
0700*		4533.1N 5827.9W (drift 1.2 nm/181°T)	N 15/20	0	1001	moderate	moderate
0700	Stern	4558.4N 5732.5W	NE 25	1	1001	slight	moderate NE
	Bow	4533N 5828.5W	NNE 15/20	0		moderate	moderate
0800	Bow	4531.1N 5828.5W (Course 175°T/1K)	NNE 15/20	0		moderate	moderate

Date[1] [2]	Reporting Vessel	Latitude & Longitude		Wind	Temp. °C	Baro.	Sea State[3] Sea	Swell	General Comments
		4559.3N	5732.8W	NNE 30	1	998	slight	moderate NE	
March 20/0800*	CCG Alert	4534N	5829W	NxE 15/20	0		slight	moderate	
0800*	CCG Alert	0400Z to 0800Z (drifted 4.3nm/194°T) (drift rate 1.07K)							
0900	Bow	4532N	5830.5W	NNE 15/20	0		moderate	moderate	
	Stern	4600N	5734.8W	NE 35 to 40	1	996	NE, moderate	moderate, NE	
0900*		4532N	5830.5W						
		(drift 1.2 nm/220°T)		NxE 20	0	998	moderate	moderate	
1000	Stern	4600.6N	5737.5W	NExE 40/50	2	996	rough	heavy NE	
	Bow	4530N	5828.6W	NNE 20/25	0		moderate	moderate	
1100Z	Bow	4529.5N	5833W	NNE 25/30	2		moderate	moderate	
	Stern	4601.2N	5741.5W	ExN 35	3	1000	rough	heavy, NE	
1200	Bow	4529N	5835.5W	ENE 30/35	3		rough	rough	
1200*		4540N	6013W	NxE 15	1.1				
1300	Bow	4528N	5838.7W	ENE 35	2		rough	rough	
	Stern	4602.8N	5746.4W	NNE 35	3	1002	rough	heavy	
1400	Bow	4526.8N	5841.3W	35	2		rough	rough	
	Stern	4603N	5749W	NE 40/45	4	1003	rough	heavy	
	Stern	pulling tug astern, tug steaming full engines ahead							
1500	Bow	4526.5N	5843.9W	E 35/40	2		rough	rough	
	Stern	4603.8N	5750.5W	ENE 35/40	3	1003.3	rough	heavy	
1600*		4525N	5844W	ENE 30/35	2		rough	moderate to heavy	
1600	Stern	4604N	5751W	ENE 35/45	3	1004	rough	heavy ENE'ly	
	Bow	4526.8	5849.1W	E 40	2		rough	rough	
1600*		4508.5N	6107.2W	NExE 35	0.6				
1700	Stern	4604.4N	5752.6W	ENE 40	3	1004	rough	heavy NE'ly	
1700	Bow	4525.7N	5848.5W	ENE 35	3		rough	heavy	
1800	Stern	4604.6N	5754.8W	NExE 35	3	1003	rough	heavy NE	
	Bow	4525.1N	5850.7W	ENE 35	3		rough	heavy	
1900	Stern	4604N	5755W	NExE 35	3	104	moderate	heavy NE	
	Bow	4525.2N	5854W	NE 30	3		rough	heavy	
2000*		4524.5N	5854W	NE 30/35	2		rough	heavy	

Date[1] [2]	Reporting Vessel	Latitude & Longitude	Wind	Temp. °C	Baro.	Sea State[3] Sea	General Comments Swell
March 21/0600Z	Bow	4519.3N 5918.5W (drift 1.4 nm, 231°T)	NExE 30/40	2	1008	rough	heavy
	Stern	4550.4N 5832.2W	NE 35/40	2		rough	heavy
0700Z	Stern	4549.3N 5836W	NE 35/40	2		rough	heavy
	Bow	4519N 5921.6W (drift 2.3 nm/261°T)	NExN 35/40	2	1008	rough	heavy
0800Z	Stern	4548.5N 5839.3W	NE 35	2		rough	heavy
	Bow	4518.2N 5923W (drift 1.3 nm, 226°T)	NExN 35/40	2	1009		
0900Z	Bow	4517.7N 5925.6W	NExN 30/35	2	1009	rough	moderate to heavy
	Stern	4547.5N 5842.5W	NE 30/35	2		rough	heavy
1000Z	Stern	4546.5N 5843.5W	NE 25/30	1		rough	heavy
	Bow	4517.9N 5928.4W	NExN 25/30	2	1009	rough	moderate to heavy
1100Z	Stern	4545N 5845.5W	NE 25/30	2		rough	heavy
	Bow	4517N 5930W	NE 25/30	2		rough	moderate to heavy
1200Z	Bow	4516.9N 5931.9W	NE 25/30	2		rough	moderate to heavy
	Stern	4544N 5848.7W (Course 238, 2K)	NE 25/30	1		rough	heavy
1206Z*		4520N 5930W	NE 20+	2		rough, no ice	moderate to heavy
1215Z*		Louisbourg Harbor	NE 25	3	1016	ice 6/10 FY 1/10 new from 1 to 3 mi off Louisbourg	moderate to heavy
1300Z	Stern		NE 25/30	1		rough	heavy
	Bow	4516N 5933.5W	NE 30	2		rough	moderate to heavy
1400Z	Bow	4515.7N 5935.2W	NE 25/30	2		rough	moderate to heavy
	Bow	section heading off wind at 225°T.					
	Stern	4541.7N 5850.6W	NE 25/30	0		rough	heavy
1500Z	Bow	4515.2N 5937.2W bow heading 235°T	NE 25/30	1		rough	moderate to heavy
	Stern	4539.8N 5856W	NE 25/30	2		rough	heavy
1600Z	Stern	4538.6N 5856.4W (course 225, 1.7K)	NE 25	3		moderate	moderate
1600Z*		4514N 5938W	NE 25/30	1		rough	moderate to heavy

Date[1] [2]	Reporting Vessel	Latitude & Longitude		Wind	Temp. °C	Baro.	Sea State[3] Sea	General Comments Swell
March 22/0500Z*		4619N	6008.5W	N 20	-2	29.94		
0500Z	Bow	4507.1N	5956.5W	N 20 to 25	-2	1014	moderate	moderate
	Stern	4525.6N	5931.6W	N 20 to 25	-1	1014	slight	slight to moderate
0600Z*		4620N	6008W	N 25	-2	29.94		
0600Z	Stern	4525.2N	5933.8W	N 18	-1	1014	slight	light to moderate
	Bow	4506.7N		N 15/20	-2	1014	moderate	moderate
0700Z*		4620.5N	6007.5W	N 15	-3	29.93		
0700Z	Stern	4524.9N	5936.6W	N 15	-1	1013	slight	slight to moderate
	Bow	4506.2N	5957.5W	N 15/20	-2	1013	slight	moderate
0800Z*		4621N	6007W	N 15	-2	29.91		
0800Z	Stern	4526N	5938.5W	N 13	-1	1014	slight NE	slighe NE
	Bow			N 15	-2	1013	slight	moderate
		(drift 0400Z to 0800Z, 2.8 nm 223°T)						
0900Z	Bow	4505N	5958.6W	N 15/20	-2	1012	slight	slight
	Stern	4526.7N	5937W	NxE 15	-1	1013	slight	slight
1000Z*		4621N	6007W	N 15	-2	29.93	Ice 10/10 snow covered first year under pressure.	
1000Z	Bow	4504.4N	5954W	N 15/20	-2	1012	slight	slight
	Stern	4526.8N	5934.8W	ENE 12	0	1013	slight NE	slight NE
1105Z*		4524N	6049.5W				open water	
1100Z	Stern	4527N	5933W	NE 15	0	1014.5	slight	slight
	Bow	4504N	5959.6W	N 15	-2	1012	slight	slight
1200Z	Bow	4504N	6000.5W	NNE 15	-1		slight	slight
		(drift 0.75 mph 228°T)						
1200Z*		4532.5N	5924W	NE'ly 15	0	1015		
1200Z*		4524.4N	6033W	NNE 10/15	0			
1300Z	Bow	4503N	6001.2W	NNE 15	0		slight	slight
1300Z*		4525.3N	6013.6W	NNE 15	1			
1400Z*		4527.3N	5956W	ENE 15	1			light
1400Z	Bow	4502N	6002.5W	NNE 15	0		slight	
1400Z*		4529.6N	6030.8W	light	1	1016		
1500Z	Bow	4501.5N	6003.5W	NNE 17	1		slight	slight
	Stern	4525.6N	5928W	ENE 15	1			light

Date[1] [2]	Reporting Vessel	Latitude & Longitude		Wind	Temp. °C	Baro.	Sea State[3] Sea	General Comments Swell
March 22/1600Z*		4524N	6105W	NW 14	1	1016	ice 6112	
1700Z	Stern	4524N	5929.2WE	NNE 20	1		slight	low
1800Z*							Ice conditions C.A. Buoy to Chedabucto Bay, 9/10 predominantly 1st yr. ice. Ice edge ends in position.	
1800Z	Stern	4522.5N	5934W	N 10	3		slight	low
	Bow	4500.5N	6006W	NNE 17			slight	slight
1900Z	Stern	4521.6N	5940W	N 15	3		slight	low
2000Z	Stern	4521.2N	5946.3W	N 15	0		slight	slight
2000Z*		4523.6N	6054.4W	light	3	1015	ice 9//0	low
2000Z	Bow	4459N	6009.5W	NE 20	0			
2100Z	Stern	4518.6N	5951W	ENE 15	1		slight	low
	Bow	4458.5N	6011.2W	NNE 20	0	1014	slight	low
2200Z	Stern	4520N	5957.5W	ENE 15	-1		slight	low
							Ice Report: Open water seaward of CA buoy. Between CA and CB buoys, loose 1st yr ice strips. Between CB and CC described as close pack strips with one-mile open pack. From CC to CE loose pack. Ice nr "Alexander" 6/10ths 1st yr ice, 4/10ths brash. 1 or 2/10ths ridging apparent in 1st yr ice with a trace of worn hummocks.	
2200Z*		4525N	6103.5W	light airs	1	1017	ice 9//0 2/10 ridged	
2200Z	Bow	4457.5N	6014.3W	NNE 10	0		slight	slight
2300Z	Stern	4520N	6002W	NNE 10	-2		slight	low
							Ice report: Cape North to Chedabucto Bay 90 to 100% covered with thick ice, except for a few narrow leads along south coast south of Scatarie Island. South of Canso loose strips of ice lie 2 to 4 miles offshore with the southern edge of the ice 10 miles south of Country Island.	
March 23/0000Z	Bow	4436N	6019W	NNE 10	-1			
0010Z*		4524.2N	6104.9W	light airs	0	1018	ice 9//0 2/10 ridged	

Date[1] [2]	Reporting Vessel	Latitude & Longitude		Wind	Temp. °C	Baro.	Sea State[3] Sea	General Comments Swell
March 23/0000Z	Stern	4521N	6002.1W	NNE 10	-2		slight	low
0100Z	Bow	4455N	6022W	NNE 15	0			
0100Z	Stern	4520.2N	6001.2W	NNE 15	-2		light	light
0200Z*		4523.7N	6050.7W	light	-1	1018.5	ice 5//2	
0200Z	Bow	4454N	6024W	NNE 12	0			
	Stern	4520.1N	5958W	N 10	-2		light	light
0300Z	Stern	4519.4N	5956W	N 10	-1		light	light
0400Z	Bow	4452N	6029W	N 10	-1			
	Stern	4520.8N	5954.1W	N 10	-1			low
0400Z*		4525.3N	6106.1W	WNW 8	-2	1018	ice 9//0	
0500Z	Stern	4522N	5955.5W	N 10	-1		slight	low
0500Z	Bow	4451N	6029.5W	N 10	-1	1017	slight	slight
0600Z	Stern	4521.8N	5959.6W	N 10	-1		slight	low
0600Z*		4524.7N	6107.2W	S 4	-2	1017	ice 9//0	
0600Z	Bow	4450N	6035.5W	N 10	-1	1017	slight	low
0700Z	Stern	4523.0N	6005.5W	NNW 10	0			low
	Bow	4449.6N	6037.6W	N 8	-1	1017	slight	low
0800Z*		4524.5N	6107.6W	NW 7	-3	1017	ice 9//0	
0800Z	Bow	4448.5N	6038.5W	N 10	-1	1017	slight	low
	Stern	4523.8N	6011.4W	NNW 10	-1			
0900Z	Stern	4523.3N	6016W	NW 10	-1		slight	slight
	Bow	4446.5N	6042.4W	N 8	-1		slight	low
1000Z	Stern	4524.5N	6021W	NW 5	-3		slight	slight
1000Z*		4524N	6104.5W	NW 4	-3	1017	ice 9//0	
1000Z	Bow	4446.2N	6044W	NNW 8	-1		slight	low
1100Z	Stern	4525N	6022W	WNW 5	-3		slight	slight
	Bow	4445.6N	6046.2W	NNW 8	0		slight	low
1200Z	Stern	4524.5N	6024W	W 5/10	2	1019	slight	slight
	Bow	4446N	6048.5W	N by W 8	1			
1300Z	Bow	4443.7N	6051.5W	N'ly light airs				

Date[1] [2]	Reporting Vessel	Latitude & Longitude		Wind	Temp. °C	Baro.	Sea State[3] Sea	General Comments Swell
March 24/1100Z	Bow	4411.4N	6147.4W	WxS 17	3		slight	slight
1200Z	Bow	4410N	6150W	SWxS 15	4			
1253Z*		Kurdistan lifeboat adrift 4454N 5938W						
1300Z	Bow	4408N	6152W	SSW 15	4			
1400Z	Bow	4407N	6154W	SSW 17	5			
1500Z	Bow	4405N	6157W	SSW 17	5			
1600Z	Bow	4404N	6159W	SWxS 15	5			
1700Z	Bow	4402.1N	6201.5W	SxW 15	7			
1824Z*		Kurdistan lifeboat at 4455N 5935W						
1800Z	Bow	4400.8N	6204.1W	SxW 15	6			
1900Z	Bow	4359.2N	6206.4W	SxW 15	6			
2000Z	Bow	4357.8N	6208.9W	SxW 15	5			
2056Z*		Kurdistan lifeboat at 4510N 5933W						
2100Z	Bow	4356.3N	6211.1W	SxW 12	5			
2200Z	Bow	4355N	6213.5W	S 12	5			
2300Z	Bow	4353.3N	6216.2W	S 10	4			
March 25/0000Z	Bow	4352N	6219W	S 10	3			
0100Z	Bow	4350N	6222W	S 10	4			
		4349N	6225W	S 10	3			
0300Z	Bow	4347N	6229W	SSW 8	3			
0400Z	Bow	4345N	6232W	SSE 10	3			
0500Z	Bow	4343.8N	6234.8W	SE 15	4			
March 25/0600Z	Bow	4342.5N	6237.6W	SE 10		1023		
0700Z	Bow	4341.5N	6241W	SE 15		1023		
0800Z	Bow	4340.3N	6243W	SE 17		1022		
0900Z	Bow	4339N	6246.2W	SE 15	5			
1000Z	Bow	4338N	6248.8W	SE 17	5			
1100Z	Bow	4336N	6250.6W	SE 17	5			
1200Z	Bow	4335N	6253W	SExE 20	6			
1300Z	Bow	4334N	6255W	SExE 23	6			
1400Z	Bow	4332N	6256W	SExE 25	6			
1500Z	Bow	4330N	6254W	SExE 25	7			

Date[1] [2]	Reporting Vessel	Latitude & Longitude		Wind	Temp. °C	Baro.	Sea State[3] Sea	Swell	General Comments
March 25/1600Z	Bow	4328N	6253W	SExE 27	7				
1700Z	Bow	4326N	6252.4W	SE 27	4		moderate	moderate	
1800Z	Bow	4324.6N	6251.4W	SE 30	4		rough	moderate	
1900Z	Bow	4323.6N	6249.7W	SE 30	4	1018	rough	moderate	
2000Z	Bow	4321.6N	6248.4W	SE 30	7	1018	rough	moderate	
2100Z	Bow	4320.5N	6247W	SE 25	7		rough	moderate	
2200Z	Bow	4319N	6246.4W	SE 30	7		rough	moderate	
2300Z	Bow	4316.8N	6246.2W	SE 27	6		rough	moderate	
March 26/0000Z	Bow	4314.5N	6245.5W	SE 25	7		rough	moderate	
0100Z	Bow	4312N	6245W	SE 30	7		rough	moderate	
0200Z	Bow	4310N	6243W	SE 30	7		rough	moderate	
0300Z	Bow	4308N	6241W	SE 30	7		rough	rough	
0400Z	Bow	4307N	6240W	SE 30	7		rough	moderate	
0500Z	Bow	4306N	6238W	SE 30	7	1012	rough	moderate	
0600Z	Bow	4305.8N	6236W	SE 30/35	7	1012	rough	moderate	
0700Z	Bow	4305N	6236W	SE 30/35	7	1011	rough	moderate	
0800Z	Bow	4304.9N	6235.7W	SE 35/40	8	1009	rough	heavy	
0900Z	Bow	4304.5N	6234.9W	SE 35/40	8		rough	heavy	
1000Z	Bow	4304N	6234.5W	SE 35/49	8		rough	heavy	
1100Z	Bow	4303.5N	6233.5W	SE 35/40	8		rough	heavy	
1200Z	Bow	4303.2N	6231.9W	SE 35/40	8		rough	heavy	
1300Z	Bow	4303N	6231W	SExS 35	8		rough	rough	
1400Z	Bow	4302N	6230W	SExS 35	8		rough	heavy	
1500Z	Bow	4302N	6229W	SExS 25/30	7		rough	heavy	
1600Z	Bow	4301N	6229W	SExS 40/45					Tow line parted from CCG Alert
1700Z	Bow	4301.4N	6230.2W	SExS 35/45	8	1003	rough	heavy	
1800Z	Bow	4302N	6231.3W	SExS 35/45	7	1002	rough	heavy	
1900Z	Bow	4301.3N	6231.3W	SSE 25/30	8	1002	rough	heavy	
2000Z	Bow	4301N	6232.3W	S 20/25			moderate	heavy	
2000Z*		4448N	6211W				rough	heavy	
2100Z	Bow	4300.8N	6230W	S 20	5		moderate	heavy	Tug Point Gilbert line to bow section parted

Date[1] [2]	Reporting Vessel	Latitude & Longitude		Wind	Temp. °C	Baro.	Sea State[3] Sea	General Comments Swell
March 26/2200Z*		4302.5N	6230.5W	S 15/20	5		moderate	heavy
2300Z	Bow	4303.8N	6231.2W	S 15	5		moderate	heavy
2400Z*		4428N	6156.5W	SSW 20	3		rough	heavy
March 27/0000Z	CCG Alert	4303.7N	6233W	S 10/15	5		slight	heavy
	Bow	4303.6N	6230.5W					
		bearing 090° at 1.5 mi. (drift 005 at 1.1K)						
0100Z*		4417.5N	6203W	SW 20	3		rough	heavy
0100Z	Bow	4304.7N	6231W	SW 10/15	5		slight	heavy
0200Z*		4408.6N	6204.2W	SW 20	3		moderate	heavy
0200Z	Bow	4305N	6230W	SW 15/20	5		slight	heavy
0300Z	Bow	4305N	6229.8W	SW 20/25	5		slight	heavy
0300Z*		4359N	6208.1W	SSW 20	3		heavy	heavy
0400Z	Bow	4306N	6228W	SW 20/25	5		moderate	heavy
0500Z	Bow	4306.3N	6230.2W	SW 20/25	4	1008	moderate	heavy
0500Z*		4339.5N	6214.2W	SW 20	3		rough	heavy
0600Z	Bow	4306.2N	6231W	SW 20/25	4	1008	moderate	heavy
0600Z*		4330.2N	6218.7W	SW 20	3		rough	heavy
0700Z	Bow	4307.1N	6230.6W	SW 20/25	4	1008	moderate	heavy
0700Z*		4321N	6222.6W	SW 20	3		rough	heavy
0800Z*		4309.5N	6231W	SW 25	3		rough	heavy
0800Z	Bow	4307.5N	6230.2W	SW 20/30	4		rough	heavy
0900Z	Bow	4311.5N	6229W	SW 25	3		rough	heavy
1000Z	Bow	4313 N	6228.5W	NW 25	4		rough	heavy
1100Z	Bow	4314N	6228W	SW 20/25			rough	heavy
1200Z	Bow	4314.7N	6226.8W	SW 25				
1200Z*		4343.3N	6256.7W	SWxW 25	4		rough	heavy
1300Z	Bow	4314.6N	6224.2W	WSW 20	4		moderate	moderate
1400Z	Bow	4316N	6223.7W	WSW 20/25	4		moderate	moderate
1500Z	Bow	4316.1N	6322.4W	WSW 20/25	3		moderate	moderate
1600Z	Bow	4315.7N	6221.7W	WSW 20/25	3		moderate	moderate
1700Z	Bow	4316.7N	6220.2W	SW 30			moderate	heavy
1800Z	Bow	4316.8N	6219W	SW 25			rough	heavy

Date[1] [2]	Reporting Vessel	Latitude & Longitude		Wind	Temp. °C	Baro.	Sea State[3] Sea	General Comments Swell
March 27/1900Z	Bow	4317.2N	6218W	SW 25			rough	heavy
2000Z	Bow	4318N	6217.2W	SW 25/30	3		rough	heavy
		(Course 070T, 1 k)						
2100Z	Bow	4318N	6216.7W	SW 25/30			rough	heavy
2200Z	Bow	4318.5N	6215W	SW 25/30			rough	heavy
2300Z	Bow	4320.5N	6213.5W	WSW 25/30			rough	heavy
2400Z	Bow	4321.4N	6212.4W	WSW 25/30			rough	heavy
March 28/0100Z	Bow	4322.3N	6210.2W	WSW 25	2		rough	heavy
0200Z	Bow	4322.4N	6208W	WSW 25	2		rough	heavy
0300Z	Bow	4323.5N	6205.1W	WSW 25	2		rough	heavy
0400Z	Bow	4322.3N	6204.5W	WNW 25	2		rough	heavy
0500Z	Bow	4321.7N	6202.8W	W 20	2		rough	heavy
0600Z	Bow	4321.8N	6201.8W	W 25	2		rough	heavy
0700Z	Bow	4322.5N	6201.3W	W 20/25	1		moderate	heavy
0800Z	Bow	4322.5N	6200.5W	W 15/20	1		moderate	heavy
		(Course 070°T, 0.8k)						
0900Z	Bow	4323.2N	6200.5W	WNW 10/15			moderate	heavy
1000Z	Bow	4323.4N	6159.5W	W 10/15			moderate	heavy
1100Z	Bow	4323.6N	6159W	WNW 10/15			moderate	heavy
1200Z	Bow	4324.2N	6159.5W	WNW 15/20			moderate	heavy
1300Z	Bow	4325.1N	6158.8W	WNW 15/20	1		moderate	moderate
1400Z	Bow	4324.2N	6156.8W	WNW 15/20	2		moderate	moderate
1500Z	Bow	4324.2N	6156W	WNW 15/20	2		moderate	moderate
1600Z	Bow	4323N	6155W	WNW 15/20	2		moderate	moderate
							Tow line from tug to bow section reconnected.	
1700Z	Bow	4321.5N	6154.3W	WNW 15/20	3		moderate	moderate
1800Z	Bow	4320N	6154W	NW 20			moderate	moderate
1900Z	Bow	4319N	6154W	NW 15 to 20			moderate	moderate
1900Z		Kurdistan lifeboat 4548.7N, 5905.5W						
2000Z	Bow	4317.7N	6152.8W	WNW 15/20	0		moderate	moderate
2100Z	Bow	4316.8N	6152.3W	WNW 10/15			moderate	moderate
2200Z	Bow	4316.4N	6152.9W	NW 15/20			moderate	moderate

Date[1] [2]	Reporting Vessel	Latitude & Longitude		Wind	Temp. °C	Baro.	Sea State[3] Sea	General Comments Swell
March 28/2300Z	Bow	4315.8N	6153W	NW 15			moderate	moderate
2400Z	Bow	4314.7N	6152.3W	NW 15			moderate	moderate
March 29/0100Z	Bow	4313.2N	6151.6W	NW 15			moderate	moderate
0200Z	Bow	4311.7N	6151W	NW 15			moderate	moderate
0300Z	Bow	4310.9N	6150.7W	NW 15			moderate	moderate
0400Z	Bow	4309.3N	6150W	NW 15			moderate	moderate
0400Z*		4351N	6242W	N 10	2		slight	moderate
0500Z	Bow	4308.1N	6149.5W	NW 15			moderate	moderate
0600Z	Bow	4306.5N	6149W	NW 15			moderate	moderate
0700Z	Bow	4304.8N	6148.2W	NW 15			moderate	moderate
0800Z	Bow	4303.2N	6148W	NW 15	-1		moderate	moderate
0900Z	Bow	4302.2N	6148.2W	NW 15			moderate	moderate
1000Z	Bow	4303N	6149W	ENE 05/10			slight	moderate
1100Z	Bow	4300.5N	6147.4W	light			slight	moderate
1200Z	Bow	4259.5N	6147.5W	light			slight	slight
1200Z*		4256N	6145W	E 6			slight	moderate
1300Z	Bow	4258.3N	6146.2W	ENE 5			light	light
1400Z	Bow	4257.6N	6145.2W	ENE 5/10			light	light
1500Z	Bow	4258.2N	6144.6W	ENE 5			light	light
1600Z	Bow	4528N	6144W	E 5/7	4			moderate
1700Z	Bow	4257.3N	6142.8W	light				
1800Z	Bow	4255.5N	6142W	ESE 5	4			
1900Z	Bow	4253N	6140W					
1915Z		Kurdistan lifeboat picked up 4530N, 5933W						
2000Z	Bow	4250N	6138.5W					
2100Z	Bow	4247.3N	6136.5W					
2200Z	Bow	4245.3N	6135.3W					
2300Z	Bow	4240N	6134W					
2400Z*		4407N	6114.5W				light	light
March 30/0000Z	Bow	4237N	6130W					slight W'ly
0100Z	Bow	4235N	6134W	E 5/8	2			slight

Date[1] [2]	Reporting Vessel	Latitude & Longitude		Wind	Temp. °C	Baro.	Sea State[3] Sea	General Comments Swell
March 30/0200Z	Bow	4232N	6131W	light airs	2			slight
0300Z	Bow	4229N	6131W	light airs	2			slight
0400Z*		4448.7N	6055.4W				slight	slight
0400Z	Bow	4226N	6131W	light airs	2			slight
0500Z	Bow	4223N	6130W	light E'ly				
0600Z	Bow	4221N	6130W	light E'ly				
0700Z	Bow	4217N	6128W	light E'ly				
0800Z*		4520.3N	6041W	SSE 15	0		slight	slight
0800Z	Bow	4215N	6127W	light E'ly				
0900Z	Bow	4212N	6126W					
1000Z	Bow	4211.4N	6123.9W					
1100Z	Bow	4209N	6121.5W					
1200Z	Bow	4206N	6120.6W		3			SE'ly
1300Z	Bow	4204N	6118W	E 10/15	5			moderate
1400Z	Bow	4202N	6116W	E 5/10	6			
1600Z	Bow	4157N	6113W	E 10	6			moderate
1700Z	Bow	4155N	6110W	ESE 10				
1800Z	Bow	4154N	6107W	E 5/10				
1900Z	Bow	4153.5N	6105W	E 5/10				
2000Z	Bow	4154.2N	6103.7W	E 10				
2100Z	Bow	4152.4N	6100.7W		6			
2200Z	Bow	4151.1N	6103.02W					
2300Z	Bow	4150.01N	6104.83W	E 10				
March 31/0000Z	Bow	4148.6N	6107.1W		6			
0100Z	Bow	4148N	6110W	ENE 10	6			moderate
0200Z	Bow	4145N	6109W	ENE 10/15	6			moderate
0300Z	Bow	4144N	6106W	ENE 10/15				moderate
0400Z	Bow	4143N	6103W	ENE 10/15	6			moderate
0500Z	Bow	4145.4N	6102.2W	E 10/15				
0600Z	Bow	4145.8N	6102.2W	E 10/15				
0700Z	Bow	4147.3N	6100.4W	E 10/15				
0800Z	Bow	4148.8N	6058.2W	E 10/15				

Date[1] [2]	Reporting Vessel	Latitude & Longitude		Wind	Temp. °C	Baro.	Sea State[3] Sea	General Comments Swell
March 31/0900Z	Bow	4150.4N	6056.4W				slight	
1000Z	Bow	4152.9N	6055.4W		3			
1100Z	Bow	4154.3N	6056.35W	NE 15				
1200Z	Bow	4154N	6058.8W	NE 15				
1300Z	Bow	4153N	6102W	NE 10/15	5			moderate
1400Z	Bow	4153N	6104W	NE 15	5			moderate
1500Z	Bow	4153N	6105W	NE 10/15	5			moderate
1600Z	Bow	4152N	6108W	NExE 10/15	6			moderate
1700Z	Bow	4149.5N	6107.8W	NE 10/15			moderate	moderate
1800Z	Bow	4148.7N	6107.4W	NE 10/15			moderate	moderate
1900Z	Bow	4147.5N	6107.2W	NE 10/15				
2000Z	Bow	4146.2N	6103.9W	NE 10/15				
2100Z	Bow	4146.3N	6101.3W	NE 15	6			
2200Z	Bow	4147.3N	6059.8W					
2300Z	Bow	4149.4N	6056.9W					
April 1 /0000Z	Bow	4150.4N	6055.7W					
0100Z	Bow	4152.4N	6054.7W	NE 5/8	6			
0200Z	Bow	4153.2N	6055.7W	light airs	5			
0300Z	Bow	4153.2N	6057.6W	light airs	5			
0400Z	Bow	4153.2N	6059.6W	light airs	6			
0500Z	Bow	4153.3N	6101.7W	E 10/15				
0600Z	Bow	4153.0N	6105.8W	E 10/15				
0700Z	Bow	4153.7N	6107.6W	E 10/15				
0800Z	Bow	4153N	6109.8W	SExE 10/15				
0900Z	Bow	4152.9N	6107.6W	SE 15				
1000Z	Bow	4154.6N	6102.9W					
1100Z	Bow	4155N	6101W	ENE 20				
1200Z*		4155N	6101.4W	E 17	6			
1300Z*		4155.1N	6101.2W	ENE 20	5			
1400Z	Bow	4155N	6101.2W	ENE 20/25	6			
1500Z		4155N	6101.3W	ENE 15/20	6			
1620Z	Derelict bow section Kurdistan sunk by gunfire at 4154N, 6102W in 2245 fathoms							

Date[1] [2]	Reporting Vessel	Latitude & Longitude		Wind	Temp. °C	Baro.	Sea State[3] Sea	General Comments Swell
April 1/1600Z*		4155N	6101.3W	NE 20	7			
1700Z*		4155.2N	6058W	NE 15/20				
2000Z*		4155N	6056.4W	N 15/20			moderate	moderate
April 2/0000Z*		4157.3N	6104.2W	NW 25	6			
0400Z*		4150N	6104W	N 25/30	4		moderate	moderate
0800Z*		4142.3N	6106W	NxW 20/30			moderate	moderate
1200Z*		4152N	6102W	NNW 25			rough	moderate
1600Z*		4157N	6057W	N 20/25	5		rough	moderate
2000Z*		4153.4N	6059.2W	NxE 15/20	5			
April 3/0000Z*		4150.6N	6057W	NE 15				
0300Z*		4440N	6201W	NE 15	0	3040		
0400Z*		4143.3N	6057.5W	ENE 10/15	5		slight	moderate
0800Z*		4138.8N	6057.4W	E 10/15				
1200Z*		4144.1N	6101.1W	SExE 10				
1200Z*		4429N	6004W	E 10	0	0335		
1600Z*		4152N	6112W	ESE 20	7		slight	slight
1600Z	Labrador	4459N	5917W	ESE 15	0	3034		
2000Z	Alert	4200.8N	6108.1W	SE 20/25				
2010Z	Labrador	4508N	5910W	SE 10	0	3027		
April 4/0400Z	Alert	4331N	6232W	W 20	5		moderate	moderate
0800Z	Alert	4413.1N	6314.7W	NWxW 20/25				
April 8/0400Z	Alert	4433N	6310W	WSW 18			slight	moderate
0800Z	Alert	4446N	6214W	WSW 15/20	2	1000	moderate	moderate
1200Z	Alert	4505N	6118W		3			heavy S'ly
1600Z	Alert	4508N	6021W	SSW 6				moderate to heavy
2000Z	Cornwallis	4523.5N	6102.5W	SW 25	3			
	Alert	4510N	6018W	SW 15/20	4		moderate	rough
April 9/0000Z	Alert	4521.3N	6044.2W	SSW 17	0		slight to moderate	slight to moderate
0400Z	Alert	4506N	6051W	SSW 22	0		moderate	heavy

Date[1] [2]	Reporting Vessel	Latitude & Longitude		Wind	Temp. °C	Baro.	Sea State[3] Sea	General Comments Swell
April 9/0800	Alert	4500N	6107W	SW 15	2		slight	moderate
1200Z	Alert	4455N	6121W	S 15	1		moderate	moderate
1600Z	Alert	4445N	6145W	SSE 17	5		moderate	moderate
2000Z	Alert	4438N	6207W	SE 20		1016		
10/0000Z	Alert	4429N	6228W	ENE 20	2		moderate	moderate
0400Z	Alert	4421N	6248W	SE 18	6			
0800Z	Alert	4414N	6316W	SSE 30	6		moderate	moderate
1200Z	Alert	4405N	6335W	SE 35/40	7		rough	heavy
1600Z	Alert	4400N	6334W	SE 40	7		rough	heavy
2000Z	Alert	4357N	6400W	SW 30			rough	heavy
11/0000Z	Alert	4350N	6412W	SSW 20	2		rough	heavy
0400Z	Alert	4344N	6421W	W 18			moderate	moderate
0800Z	Alert	4338N	6435W	W 25	4		moderate	moderate
1600Z	Alert	4329N	6455W	WSW 25	4		rough	heavy
12/2000Z	Labrador	4537N	6005W	N 10	+1	2986		
13/0000Z	Labrador	4505N	6111W	N 15	1			

APPENDIX III

OIL SIGHTING REPORTS, MARCH 15 - MAY 31, 1979
CABOT STRAIT, SCOTIAN SHELF AND MAINLAND, NOVA SCOTIA

EXPLANATION

Oil sightings were compiled from various sources, including Canadian Coast Guard Pollution Reports, Environmental Protection Service Pollution Reports, Bedford Institute of Oceanography cruise reports, cruise reports of the Fisheries Marine Service 'Lady Hammond", personal sightings by BIO field personnel, and from private communications. Also see Trites (this report) and O'Boyle (BIO Report Series, BI-R-80-3).

(1) Time of oil sighting report (Z = Zulu, ADT = Atlantic Daylight Time, EST = Eastern Standard Time)

(2) For locations consult location map in front of this report.

(3) US Coast Guard tar code.

VISIBILITY OF OIL DISCHARGES

Thickness-Appearance Relationship (from U.S. Coast Guard T.A.R. Code)

Appearance	Thickness Range (nanometers)	Description	T.A.R. Code
Colorless films	Up to 150	Films reflect more light than does water, and look brighter. May need adjacent bare water for comparison. Apparent brightness increases with thickness. At about 75 nm and thickness, a pearly or metallic luster is usually apparent.	1
Onset of Color	Approx. 150	First color seen is a warm tone, more bronze than yellow. As film thickens, deep violet or purple appears; these colors begin the first set of rainbow bands.	2
Pure Rainbow Colors	150 to 900	The set of bands around 300 nm are in the sequence: bronze, purple, blue, green, in order of increasing thickness. These colors are pure and intense. The set of bands around 600 nm are slightly less intense than at 300 nm, and have a modified color sequence: yellow, magenta (reddish violet), blue, green. They are quite pure.	3
Dull, Impure Colors	900 to 1500	Main characteristic is reduction in number and purity of colors. Colors at 900 nm are a rich terra cotta (brick red) and turquoise (rather bright blue-green). At 1200 nm and 1500 nm these colors are progressively duller or less pure looking. These sites of bands may also contain a trace of white or pale yellow.	4
Light and dark bands	1500 to 3000	Any color present is merely a tint in the light and dark alternating bands. At 1800 nm, the contrast between light and dark bands is strong, but weakens as thickness increases. At 3000 nm, it is apparent that interference effects are weak, and they will quickly disappear as thickness increases.	5

Date	Time[1]	General Location[2]	Specific Location, Report Description
March 15	-	Laurentian Channel	4655.8N 5939.7W; slick reported
March 16	1347Z	Laurentian Channel	4634N 5914W; slick reported near Kurdistan stern section
	1525Z	Laurentian Channel	Two by five mile slick between stern and bow sections, tar code #1, drifting SSW[3].
March 18	-	Laurentian Channel	4547N 5810W; oil reported
March 20	1730Z	Scotian Shelf - east	4525.3N 5848.7W; 8 to 10 foot slick of Bunker C, 10 to 12 slicks behind bow section with a dead bird in it.
March 21	1200Z	Laurentian Channel	4520N 5930W; three nm NE of bow section, two oil patches 30'x30'.
March 22	1317Z	Laurentian Channel	4536N 6020W; large amounts of oil in water, continuing along flight track in SW direction.
		Cape Breton	Fourchu Head. Tracker report of significant amounts of oil in ice one to two miles from shore.
March 23	2100Z	Scotian Shelf - east	4500N 5930W; "Enormous 20 foot diameter round patches and considerable number of small oily patches. Color of patches was very dark, nearly black. View was into sun. Small birds observed lifting from the surface but dropping back after short distance. Opinion of master and crew that birds affected by oil, but not confirmed by observation. Vessel was in view of oil patches for one hour. No oil adhered to hull. Vessel was proceeding at approximately six knots, sea flat, wind from 200 force 2" (Report from Dart Europe).
			Later report same area: ca. 15 miles of heavy Bunker C and globules drifting SW.

1 Time of oil sighting report (Z=Zulu, ADT = Atlantic Daylight Time, EST=Eastern Standard Time)
2 Refer to location map for general areas.
3 USCG tar code.

Date	Time[1]	General Location[2]	Specific Location, Report Description
March 23 Cont'd.	-	Cape Breton	Oil frozen into the ice from Red Point to Forchu. Close inshore at Fourchu, Framboise, Pt. Michaud. Big slick off Red Point. Very little of Gros Nez Island. No birds or sign of dead birds. (A.R. Locke, CWS).
	-	Cape Breton	Stained ice offshore and east of Pt. Michaud. One mile long patch, 20 to 100 feet wide offshore from Pt. Michaud. Oiling consists of a lot of smaller patches and sheens, as well as larger areas. The largest contaminated area containing Bunker C was ca. 1 sq. mile. Nearshore Fourchu the same oiling pattern, streaks parallel to the beach, ca. 150 feet offshore. Several 100 ft long and 20 to 100 ft. wide. (R.W. Trites, Hudson report).
March 24	-	Sable Island*	A few blotches of oil with birds stuck in it. Blobs and balls (fist size) all over beach on north shore, ca. 4 to 5 miles. Small balls arrived at high tide line, since last tide. Heavy black tar, really thick and sticky. This is first tar seen on Sable Island since January 1978. Dead birds have washed up since the night before.
March 24	1255Z	Scotian Shelf - east	4454N 5938W; 10 ft. diameter black crude around Kurdistan life boat.
	1855Z	Scotian Shelf - east	Oil 1 nm in diameter. Ten patches, heavy and dark in color. Largest oil patch 50 ft in radius, smallest 10 ft radius. Photo graphs taken. (Tracker report).
	-	Cape Breton	Point Michaud to Fourchu; oil-in-ice report (unconfirmed).
March 25	0540Z	Scotian Shelf - east	4510N 5938W; 100 ft by 50 ft oil slick, appeared to be Bunker C.
	-	Sable Island	Oil on north side. Oil as 'pads' and balls.
	-	Sable Island*	Circa 10 birds have been picked up. At least another 5 to 10 more. Some of these carcasses thought to be quite fresh. Oil along entire water edge, as dollar size blobs.

* Oil later identified as not belonging to Kurdistan spilled cargo oil. (viz. Brown, this report.)

Date	Time[1]	General Location[2]	Specific Location, Report Description
March 30 Cont'd.	1535Z	Scotian Shelf - east	4541N 5948W; oiled spotted, heavy crude three to four miles long.
		Cape Breton	Oil report near Louisbourg.
		Scotian Shelf - east	Cape Scotia reported leaving Louisbourg evening 29th and 35 mi SE Louisbourg sailing through oily patches for 4 hours. Significant number of oiled birds.
		Cape Breton	Small globules of oil on south bar Sydney Harbor.
April 1	1051Z	Scotian Shelf - east	4530N 5850.25W; 6 small heavy oil slicks. Largest approximately 100'x100'. Smallest 25'x6'. Edges well defined and covered with snow.
	1500Z	Scotian Shelf - west	Slight oil slick 2 cables long by 1 cable near sunken bow of Kurdistan.
	1620Z	Scotian Shelf - west	Oil slick (at sunken bow site), not heavy oil. Spreading fast.
	-	Cape Breton	One mile either side of Fuller's Bridge along shoreline. Description small 'drips' or globules of heavy oil generally 1 to 2" in diameter. Oil on the ice along shore. One or two patches the size of a dinner plate.
April 2	2040Z	Scotian Shelf - west	Slight oil slick in patches near bow disposal site. Occasional small amounts of sludge seem to surface producing a film similar to tank cleaning which spreads rapidly and dissipates. Nothing significant and no trace of Bunker C or heavy oil sighted.
	2113Z	Scotian Shelf - west	4156N 6058W; oil slick, tar code 2 to 3. 14 miles long by 100 to 400 ft wide. Photographs were taken. (Tracker 2173 report).
April 3	1200Z	Scotian Shelf - west	4144.1N 6101.1W; patches of light oil with occasional small amounts of sludge. No heavy oil concentration.

Date	Time[1]	General Location[2]	Specific Location, Report Description
March 27	-	Cape Breton	Oil in ice near Michaud.
		Chedabucto Bay	1 to 1 1/2 miles of beach, Heath Point to Red Head, on Petit de Grat showing some lumps of Bunker type oil on beach with some large globules on ice immediately offshore. Some oil one mile offshore in ice outside Petit de Grat harbor.
	-	Cape Breton	Oil-contaminated ice on shore and offshore from Michaud Point as far nort as Mira Bay (C-CORE report).
	-	Cape Breton	Patches of Bunker C oil on ice and on shore E to NE of Fourchu lighthouse station. Not any great quantity.
March 28	-	Cape Breton	Oil sighted on beaches and on cliffs around Guyon Island. Two of the gulches on the western tip of the island have large blotches in the water, and along the shore. Type Bunker C. Amount approximately five 45-gallon drums full.
	-	Scotian Shelf - east	4551N 5920W; small patches of heavy oil, numerous patches about 10 by 20 feet in size drifting NE.
		Cape Breton	Oil blobs and spatters on ice-floes offshore from Pt. Michaud to Louisbourg. Shoreline oiling with particulate oil on St. Esprit I.
			Slick 26.5 mi long and half width of the ship.
March 29	-	Scotian Shelf - east	4550N 5905W; minor patches of oil in area, spread out in small quantity of no importance.
	-	Scotian Shelf - east	4550N 5932W; broken ice in area with quite a lot of black oil amongst it. Seems to be holding oil in pools.
	2125Z	Scotian Shelf - east	4504N 5944W; oil patch of 2 nm radius.
March 30	-	Scotian Shelf - east	Oiled fishing gear about 60 mi offshore Cabarus/Louisbourg southerly. (Fishing vessel Cape Norman).

Date	Time[1]	General Location[2]	Specific Location, Report Description
April 3 Cont'd.	1324Z	Scotian Shelf - west	4359N 5934W; diesel and crude oil slick 50'x300' drifting SW.
	1600Z	Scotian Shelf - east	4445.5N 5941.2W; spotted 9 blobs of heavy oil ranging in size from 3' diameter to 15' diameter. (CCGS Labrador).
	-	Scotian Shelf - east	4445.2N 5927.4W; 14 blobs of heavy oil 5' diameter to 15' diameter. Estimate 2700 square miles covered (CCGS Labrador).* "A total of 34 circular shaped blobs of heavy of average size four feet diameter to six feet diameter. They were floating at water level and had a consistency which resembled soft rubbery tar. No oily film was present and they left no trace in the water. The blobs could only be detected at close range or by flying directly overhead." (CCGS Labrador).
April 6	1550Z	Scotian Shelf - west	4150N 6045W; large oil slick 7 miles long and 7 miles either side ranging NW to SE - tar code 1 to 5, thicker in center. Also three distinct bands of oil 1 mile by 12 miles long ranging NW to SE. Photos taken. (Tracker 2185 report).
	2112Z	Cape Breton	4531N 6058.5W; 3 or 4 blobs of oil on beach at Bewers Pond, Bay of Rocks.
	2238	Cape Breton	1 1/2 - 2 miles of Melford Beach contaminated, thick blobs and sheets of oil are coming ashore. Appears to be Bunker C. An estimated 300 gallons of oil involved.
April 7	-	Chedabucto Bay	Oil in Arichat Harbour, and oil in ice near Petit-de-Grat Coop plant.
	1730	Eastern Shore	"Several patches of heavy tar like substance, possibly bunker C oil from tanker Kurdistan. Some patches approximately two feet in diameter on shore at Whitehead I. Also local fishermen reported seeing similar patches ashore at Whitehead", (Light-keeper).
	1855	Chedabucto Bay	Oil on beach near Petit-de-Grat, not Bunker C.

* Ed's note: presumably refers to area of search area.

Date	Time[1]	General Location[2]	Specific Location, Report Description
April 7 Cont'd.	1855	Chedabucto Bay	Little globules of what appears to be Bunker C in ice along Arichat shore, and mixed in ice.
	2127Z	Eastern Shore	Little Dover; small amounts about 5 to 8 patches of 6 to 7 in diameter of what appears to be Bunker C floating in water mixed with seaweed. At the south end oil entrapped in rocks. Total oil approximately 2 to 3 gallons.
April 8	1600Z	Cape Breton	Patches of oil varying in size from 5 to 20 feet in diameter extending in an approximate line from 4538N 5945W towards Canso Town. Numerous patches of oil along ice edge from Fourchu to Red Cape. Patches vary in size, up to 6 feet in diameter. Did not see any great masses of oil. Ice extending approximately 1 mile from shore.
	2034Z	Eastern Shore	Little Dover; patches of heavy oil varying in size from 3 to 4 inch blobs up to patches 2 feet in diameter. Saw approximately 15 to 100 patches concentrated in this area. Concentration lessened and no oil patches seen west of Whitehead I. lighthouse.
April 9	1516Z	Eastern Shore	Small spots of oil ashore on Cranberry I.
	1623Z	Scotian Shelf - west	In position 4150N 6045W blobs of oil sighted, creating streaking similar to oil from No. 3 tanker of Kurdistan.
	1722Z	Cape Breton	"Lots of oil ashore on southeast side of Guyon Island."
	1820Z	Scotian Shelf - west	Two spills 4527N 6034W, 15 foot radius, heavy oil. Photographed.
	2114Z	Cape Breton	St. Esprit to Fourchu - oil visible half-way St. Esprit to Red Cape. Patches 3 to 4 and 6 to 10 fet. At Red Cape oil appears to migrate towards shore as far as 60 feet from ice edge. Fourchu to Gabarus Bay - oil blobs increasing in frequency on ice edge. Fourchu Bay to Guyon Island - blobs 3 to 4 and 6 to 10 feet diameter. Concentration of oil blobs west of Guyon Island and off Cape Babarus.

Date	Time[1]	General Location[2]	Specific Location - Report Description
April 9 Cont'd.			Gabarus Bay to Scatarie Island - increase in frequency of oil, 6 to 12 feet diameter, entrance of Gabarus Bay to Black Rock Point, where sizes increase to 15 to 20 feet diameter. Blobs occasionally migrating 100 to 200 feet in from ice edge. Black Rock Point to Cape Breton - blobs 3 to 10 feet too numerous to count. Cape Breton to Scatarie - blobs decreasing at about 5 miles east of Scatarie to nil count.
	2130Z	Cape Breton	Bunker C type oil on shore of Guyon I. in approximately 15 locations. Lighthouse keeper reports pans of oil coming ashore approximately 6 inches thick. Size of pan varies from 6 in to 4 ft. More oil pans presently in ice in area of Guyon I. Saw 8 pans of oil in water concentrated along eastern side of search area. Quantities much fewer than yesterday.
April 10	1701Z	Eastern Shore	"Patches of oil south/east shore of Cranberry Island and rocks. Average 6 to 8 inches diameter, mostly small blobs. Andrews Island Little Dover to Whitehead Island lighthouse - patches seen in water along shoreline, larger patches breaking up into small patches. First time seen in this area. Oil coming ashore east town Little Dover on gravel beach, one large patch on beach 8 to 10 feet long and 4 to 5 feet across, estimated 2 to 3 inches thick. Now have patches every 6 to 7 feet along beach. Two days ago this beach was clean. Sandy beach 1 mile south this location, large pan 7 by 5 feet ashore now. All along this area concentration appears to be increasing." (Helicopter flight 1030L).
	1735Z	Eastern Shore	Several patches of Bunker oil coming ashore south side of Whitehead I. A couple of patches 8 to 10 feet wide.
	1935Z	Cape Breton	Michaud to St. Esprit I; "oil in ice edge - small globules (silver dollar size) up to 3 or 4 feet in diameter. Reportedly highest concentration seen. On return from Point Michaud to Petit-de-Grat oil in ice also. Slicks in ice 20 to 30 feet from the edge, 10 to 15 long and 2 to 3 feet wide. Oil is mixed with ice due to compression of ice. The ice is moving closer to the shore. In most areas is 5 to 100 feet from shore." (Helo flight).

Date	Time[1]	General Location[2]	Specific Location, Report Description
April 10 Cont'd.	2156Z	Scotian Shelf - east	4548.5N 5846W; "passed area of 30 to 40 square feet of thick Bunker oil" (Imperial Quebec report).
April 11	1201Z	Scotian Shelf - east	Flint Island; "small amounts of heavy Bunker oil showing up on north and south shoreline of station" (Light-keeper).
	1401Z	Eastern Shore	Quite an amount of oil on Conway beach at head of Whitehead Harbour. (Lightkeeper).
	1740Z	Cape Breton	"Patches of Bunker C oil on Fourchu Head beach and rocks from north to west of station clockwise." (Light-keeper).
	2000Z	Scotian Shelf - east	4548.5N 5846W; no oil sighted on overflight of earlier oil report area, Imperial Quebec (10 2156Z).
April 12	1505Z	Eastern Shore	"Bunker C oil washing up on south and southeast beaches of Country I. Approximately 2 drums of oil. We usually don't get any drift on these beaches, so that may be much more oil would be present on inner beaches." (Light-keeper).
	1722Z	Scotian Shelf - east	4629N 5957.5W; oil slick, appears to be Bunker C, about 15 feet square.
	1743Z	Scotian Shelf - east	Oil slicks from 4629.5N 5957.5W to 4633N 5955W. Passed five small oil slicks.
	1856Z	Eastern Shore	Oil soaked birds at Ecum Secum. (Fisheries officer).
		Scotian Shelf - west	At position 4200N 6100W very little irridescence, no globs of oil. 30 to 40 globs of oil 3 to 5 ft in diameter were sighted 50 to 60 miles bearing 260 degrees from position 4200N 5930W. Bright irridescence emanating from each.
	2107Z	Scotian Shelf - west	Oil-coated gulls on Emerald Bank.

Date	Time[1]	General Location[2]	Specific Location, Report Description
April 13	1242Z	Scotian Shelf - east	Two slicks in Position 4623N 6003W and 4624.3N 6002W, heavy crude or Bunker, approximately 20 ft by 20 ft.
	1324	Scotian Shelf - west	Fishing gear moored 15 miles south of Devils Island was covered in heavy black oil. Appears to be Bunker C. Also gear moored 1/4 mile away covered in oil. (G. Edwards, Eastern Passage).
	1340Z	Cape Breton	Beach on Ocean Street and Cranberry Beach, Sydney Mines, has oil blobs on it about 4 to 5 feet, and several more in surf along the shore.
	1402Z	Cape Breton	Oil blobs 1/4 mile offshore from Glace Bay. Some 12 feet in diameter.
	1419Z	Cape Breton	Oil on beaches, Cranberry Hill area of Sydney Mines. More in water. Heavy Bunker C globs that can be easily picked up.
	1427Z	Cape Breton	Oil on beaches at Port Morien.
	1441Z	Cape Breton	Oil washing up on beaches from Cranberry Head, Sydney Mines, to Pt. Aconi.
	1446Z	Cape Breton	Oil blobs, some 5 to 6 feet in diameter, and many smaller patches, South Bar.
	1549Z	Cape Breton	Big Bras D'Or; 6 to 7 small blobs of Bunker C along the 300 ft of beach between range lights near old ferry crossing.
	1533	Cape Breton	Oil blob 12 ft by 12 ft off Donkin Beach, Glace Bay.
	1549Z	Cape Breton	Oil in Glace Bay harbour and Dominion Beach.
	1603Z	Cape Breton	Oil in water off bridge, Glace Bay.
	1610Z	Cape Breton	Ferry Marine Nautica passed 5 or 6 blobs of oil last half hour, 5 miles from Low Point.

Date	Time[1]	General Location[2]	Specific Location, Report Description
April 13 Cont'd.	1640Z	Cape Breton	Terrible mess on beaches near Glace Bay. Blobs of oil with some dead ducks and wildlife.
	1642Z	Cape Breton	Oil on ice and on beaches of Port Morien. Dead Birds in oil.
	1647Z	Cape Breton	Oil on every 10 to 15 yards on shore at Low Point. Two feet in diameter, and some larger.
	1655Z	Cape Breton	Glace Bay; three foot blobs (3 ft sq) every 6 to 8 feet, some six feet across on beach near No. 26 colliery.
	1710Z	Cape Breton	Quite a large amount of black oil in water off Dominion.
	1739Z	Cape Breton	Bunker C oil washed ashore on north shore of Green Island.
	1853Z	Cape Breton	Oil washed up on shore, entrance to Big Bras D'Or, about one inch thick.
	1926Z	Cape Breton	Heavy oil in large amounts inshore in New Waterford.
	1928Z	Cape Breton	Oil on beaches on north side of Mira Bay.
	2008Z	Cape Breton	Oil on the beach of Big Bras d'Or, at least a dozen globs.
	2215Z	Cape Breton	Oil on the rocks of Low Point.
		Cape Breton	Oil between Guyon Island and mainland.
	2242Z	Cape Breton	Heavy oil washing up on beaches in Fourchu, including dead birds.
	2248Z	Cape Breton	Blobs of oil and oil in ice washing up on beaches, near Mira Gut.
April 14	1307Z	Cape Breton	Approximately five blobs of Bunker oil have washed ashore with the tide in Sydney Harbour.

Date	Time[1]	General Location[2]	Specific Location, Report Description
April 14 Cont'd.	1318Z	Cape Breton	Small amount of heavy oil spotting beach area in St. Esprit. Some dead birds.
	1332Z	Cape Breton	Coin-size and larger blobs of oil washed up on Dominion beach.
	1420Z	Eastern Shore	Over two hundred oil-covered birds (all species) in Moser River area. (Fisheries officer report).
		Eastern Shore	Fishermen report no oil sightings, but oil reported at Fancy Point.
	1420Z	Cape Breton	First oil sighted on beach north side of Scatarie Island from Seal Rocks cove to East Point light. Cup-size to two sq meters, Bunker C oil. Also lot of small shorebirds and ducks.
	1422Z	Eastern Shore	Lots of blobs of oil on shore at Mira Gut. Came ashore in ice.
	1608Z	Eastern Shore	Oil Coming onto shore, quite badly, around Indian Beach area, North Sydney.
	1613Z	Eastern Shore	Little Pond and Sydney Mines beaches have quite a bit of oil on them. Quite a bit is still coming in.
	1619Z	Cape Breton	Sighted oil slicks east and northeast of Flint Island station approximately 200 yards square. Also several patches on shore 4 ft square. (Lightkeeper).
	1602Z	Cape Breton	Ferry Marine Nautica sighted 25 to 30 globs 4 miles off Low Point.
	1630Z	Cape Breton	Kelp around Little Pond reported full of oil.
	1700Z	Cape Breton	Oil on the beach on eastern side of Dominion and more in the water. Reports of oil on beaches between Glace Bay, New Waterford, Sydney and Dominion.
	1802Z	Cape Breton	Oil on front and back beaches of Florence.

Date	Time[1]	General Location[2]	Specific Location, Report Description
April 14 Cont'd.	1810Z	Cape Breton	Oil washed up along beach and on the ice in Catalone Gut, around Louisburg and MacDonalds Pond.
	1818Z	Cape Breton	Oil reports on Catalone beach in Mira Gut area. Quite a bit of scattered oil in a two-mile distance.
	1857Z	Scotian Shelf - west	4332N 6400W; 3 slicks approximately 1 quarter mile long, appears to be Bunker oil. (M/V "Suzanne").
	1918Z	Cape Breton	Oil on beach at Pt. Michaud, on eastern side small blobs 8 inches in diameter.
	1920Z	Cape Breton	Morien Bay shore is saturated. Size of drops up to 1/2 gallon size. All along half a mile of shore.
	1932Z	Cape Breton	Oil slick 6 feet wide along shoreline at Morien Bay, halfway up to the head of the bay.
	1942Z	Cape Breton	All along the shoreline at Port Morien belwo black brook are big blobs of black oil.
	1957Z	Cape Breton	Large amounts of oil on beach in Port Morien area.
	2026Z	Cape Breton	Oil at Mira Gut, 2/4 mile up river and oil on the rocks.
	2027Z	Cape Breton	Oil on the beach near South Head road, Pt. Morien.
	2030Z	Cape Breton	Oil off yacht club at North Sydney, Black blobs, very thick, visible standing up above the water.
	2036Z	Cape Breton	Oil in gobs in south side of Mira Bay. Some oil out on the ice.
	2050Z	Cape Breton	Patches of heavy oil up to 1 meter in diameter, 1 cm to 4 cm thick, off SE Cape Breton from 4534N 6023W to 4550N 6003W.

Date	Time[1]	General Location[2]	Specific Location, Report Description
April 14 Cont'd.	2129	Cape Breton	Lloyds Cove at the mouth of Sydney Harbour was clear this morning. Three hours later it was covered. Beach is coated with oil. There are sea birds in it.
	2130Z	Cape Breton	There is lots of oil on Mira Gut Bay beach.
	2131Z	Cape Breton	An oil slick at Sydney Mines, coming in very slowly. It is near Greene's hill, Shore Road. There is a lot coming in.
	2146Z	Cape Breton	Oil on the Mira River 1/4 miles up the further upstream.
	2139Z	Cape Breton	Concentrated Bunker oil from 4635.5N 5955W to Low Point, in size from small to 100 or 150 feet across. (V/L "Marine Atlantica").
	2148Z	Cape Breton	Oil on Lockman Beach, Sydney Mines. Oiled birds.
	2203Z	Cape Breton	Oil on shore and on the rocks at Mira Gut.
	2222Z	Cape Breton	700 to 800 feet of the sand bar at the head of Port Morien covered with oil.
	2347Z	Cape Breton	Oil on shore between Lingan at the new plant and New Waterford town.
April 15	0010Z	Cape Breton	Dead seal full of oil at Catalone on Mira Gut beach.
	0052Z	Scotian Shelf - west	Area of heavy thick oil covering 4 to 6 mile area near LaHave bank area. Oil sometimes up to 6 inches thick. Loran reading 1H2 1750 and 1H7 1550 to 1500.
	1328Z	Cape Breton	Globs of Bunker C oil in Sydney Harbour on the Pt. Edward side. Globs about 3 feet in diameter observed while nets being set out on the northwest arm of Pt. Edward.
	1533Z	Cape Breton	Quite a large oil slick 50 yards offshore, New Waterford.

Date	Time[1]	General Location[2]	Specific Location, Report Description
April 15 Cont'd.	1545Z	Cape Breton	No oil sighted, but there are oil-soaked dead birds on beach at Point Aconi.
	1548Z	Cape Breton	Oil on Pt. Edward beaches and going up the creeks.
	2010Z	Cape Breton	Sand bar at Port Morien is full of thick black oil.
	2026Z	Cape Breton	At the back beach at Florence there is more oil than there was yesterday.
	2350Z	Cape Breton	Oil on beach and in eelgrass around it three miles Mira River.
April 16	1314Z	Eastern Shore	Oil on the rocks on the Sonora beach near Sherbrooke. Sheep and lambs have oil on them. Some lambs have died.
	1340Z	Scotian Shelf - east	4542.7N 5952.8W; backwash brought to the surface congealed Bunker oil. This covered an area of about two miles. There was no indication of oil on surface, only showed in backwash (Vessel report).
	1417Z	Eastern Shore	Report of dead birds on Silver Island, Sheet Harbour.
	1436Z	Cape Breton	Oil on shore at Point Edward.
	1501Z	Cape Breton	Oil in the bird sanctuary at Glace Bay, also at the heavy water plant.
	1511Z	Eastern Shore	Fishermen report large oil slick off Southlands Island near Sheet Harbour. Oiled and dead birds in the area.
	1715Z	Cape Breton	Birds full of oil at Donkin.
	1727Z	Cape Breton	30 or 40 blobs of oil, some larger ones, along mile beach at the mouth of Mira River.

Date	Time[1]	General Location[2]	Specific Location, Report Description
April 16 Cont'd.	2153Z	Chedabucto Bay	Heavy oil extending from Cape LaRond to Poulamon through Lennox Passage in spurts and patches.
	2225Z	Cape Breton	Oil-covered seabird between Cape Smokey and Englishtown at Little River. No oil sighted, but there is a heavy odor of oil in vicinity.
	2212Z	Eastern Shore	Cranberry Island lightkeeper advises more oil coming ashore today.
April 17	1523Z	Eastern Shore	West Dover; fishing gear oiled on a track from the Halifax ship buoy on the 2400 Loran line.
	1910Z	Cape Breton	Back shore beach and gut area near Florence are polluted with oil.
April 18	1223Z	Chedabucto Bay	200 yards long narrow strip of oil one mile SW of Green Island light-station.
	1300Z	Cape Breton	Oil coming ashore in spots and patches from Phillips Harbour to Half Island Cove.
	1316Z	Cape Breton	Large patches of heavy blobs of oil coming ashore at Waddens Cove, False Bay beach in the Mira Bay area.
	1408Z	Cape Breton	Oil on beaches from Rochfort Point to White Point, Louisbourg.
	1620Z	Eastern Shore	Patches of heavy oil off outside ledges washing onto beaches near Little Dover, Guysborough Co.
	1736Z	Cape Breton	Oil driven in between the piers of Ambrose Shea and William Carson, CN Marine Ferries, North Sydney. Area about 50 ft x 100 ft.
	1750Z	Cape Breton	Heavy oil lining the Little Lorraine Harbour shore line and approaches to the harbour.
	1907Z	Scotian Shelf - west	Oil slick at 4154N 6102W southward. 8 to 10 miles long by 3 to 4 miles wide. Patches of heavy crude. Photos taken (Tracker 2168 report).

Date	Time[1]	General Location[2]	Specific Location, Report Description
April 18 Cont'd.	1932Z	Eastern Shore	Oil on beaches of Fox Island mainland, Guysborough Co.
	2003Z	Cape Breton	Very heavy concentrations of oil on beaches of the area. Some dead birds. Big heavy mattress-like blobs, some estimated 800 to 900 gallons.
	2054Z	Cape Breton	Large amount of oil on south side of Point Aconi light.
	2109	Cape Breton	Large patches of oil coming ashore, and going by the Wadden Cove area, mira Bay. Some lumps 25 feet square and 8 to 10 inches thick. Some lumps weigh about 100 pounds.
April 19	0903Z	Cape Breton	Oil slick extending from north bar, North Sydney to Point Edward. Appears to be of considerable size (Ferry "Marine Nautica" report)
	1334Z	Cape Breton	More oil ashore after clean-up at Munroe Park, North Sydney area.
	1640Z	Cape Breton	Large globs of heavy oil on beach east of Louisbourg light-station.
	1904Z	Scotian Shelf - west	Bunker oil sighted at 4156N 6100W. Samples taken (CCGS "Alert").
	1959Z	Scotian Shelf - west	4158N 6100W. "At northern edge of oil slick. Have approximately two buckets of oil sample. One sea bird, recovered from oil. Oil slick appears to be in southerly direction from earlier (1830Z) position. Present time proceeding south to investigate length of slick. Slick appears to be 50 to 200 ft wide with patches of congealed oil five to eight square feet and twenty to forty feet of loose oil and large area of discolored water."
	2100Z	Cape Breton	Additional oil deposits found on beach at Glace Bay, north and south shores of Mira Bay, in the harbour of Louisburg, and in Port Morien.
	2142Z	Cape Breton	Four large slicks off beach at Port Morien, 50 ft by 50 ft.

Date	Time[1]	General Location[2]	Specific Location, Report Description
April 19 Cont'd.	2230Z	Cape Breton	Small blobs on Lingan beaches. Two dead birds and one live bird.
	2334Z	Eastern Shore	Numerous ducks and seagulls covered in oil on Stoney Island, Tangier. No sign of oil on beaches or on water.
April 20	1328Z	Eastern Shore	Heavy oil on beach of Fox Island, Guysborough Co.
	1430Z	Cape Breton	In position 4558.30N 5935.30W, proceeding seaward one mile towards Fourchu. Heaviest concentration of oil Louisbourg point 5 1/2 miles SSE. Oil blobs the size of baseballs in area about 10 ft apart. Encountered five blobs 5 ft square bearing 165° magnetic 5 1/2 miles from Big Loraine. Almost no oil from Baulane Cove to 4558.30N 5935.30W.
	2322Z	Cape Breton	Beach at Big Bras d'Or at the entry to Bras d'Or lakes has quite a lot of oil covering one whole area of beach. the oil came in with the hide this evening. Area is approximately 400 yards from the range lights.
	2346Z	Cape Breton	Fishermen reported oil caught in traps and boats near St. Ann's Bay. Several blotches and small blotches on the south shore of St. Ann's Bay.
April 21	0127Z	Cape Breton	Wind, tide and wave action during the night of April 19/20 had carried patches of oil on the shores at the entrace to Great Bras d'Or and Little Bras d'Or. (Aerial reconnaissance).
	1344Z	Cape Breton	Oil on beaches, 5 ft square blobs, every 50 ft from English Town Ferry to River Bennett (4620N 6032W).
	1359Z	Cape Breton	Considerable amount of oil at center of Lingan sandbar.
	1430Z	Cape Breton	Considerable amount of oil came into Mira Bay along the beach at Main-à-Dieu last night.

Date	Time[1]	General Location[2]	Specific Location, Report Description
April 21 Cont'd.	1617Z	Cape Breton	Oil on north side of Guyon Island. Some oil in the cove where boats are hauled up. Some more in the next cove to it. Maybe 3 barrels or more. Some on the shore, with the rest in the water.
April 22	0954Z	Cape Breton	Oil slick in position one half mile southwest of Channel Head, running in west and north direction. Estimated approximately 1,000 ft, and numerous patches. It is black in color, ragged on outer edges. (Report from Ferry "Marine Nautica").
	1444Z	Cape Breton	Beach in Glace Bay is covered in heavy oil.
	1957Z	Chedabucto Bay	Oil a mile south of Cape Auget, near Mackerel Cove, 4 miles west of Green Island. Some pancakes.
	2011Z	Cape Breton	Oil on the rocks on the beach for 1/4 mile to the west of the old Big Bras d'Or ferry dock.
April 23	1346Z	Chedabucto Bay	Oil slick at Petit de Grat wharf.
	1438Z	Eastern Shore	Oil report from Whitehead.
	1516Z	Eastern Shore	A lot of big blobs on the False Bay beach, and mixed with rocks and sea weed, between Homeville and Round Island.
	1630Z	Eastern Shore	Oil along the beach, containing sea ducks, at Black Duck Cove, Hungry Island and Beach Cove, near Little Dover.
	1710Z	Cape Breton	Oil in Glace Bay Lake, near the bottom in the town of Glace Bay. Also a lot of oil around the Seaboard Power Plant.
	1816Z	Cape Breton	Eagle Head Bay full of oil.
	1938Z	Halifax	4-month old seal found previous Saturday at Portuguese Cove. It was completely covered with oil, and was unrecognizable as a seal. Oil looks like Bunker C, a very thick, heavy oil. Photographs taken.

Date	Time[1]	General Location[2]	Specific Location, Report Description
April 23 Cont'd.	2227Z	Cape Breton	"Quite a bit of oil" 18 to 20 miles southeast by east from Louisbourg light.
	2330Z	Cape Breton	Oil entering lake from Little Bras d'Or due to boom break.
April 24	1632Z	Eastern Shore	Bunker C in Eagle Head Bay, Little Dover, from low water to high water makr, about 2 miles long and 5 inches thick on the beach. Quite a few oil-covered birds.
April 25	1100Z	Scotian Shelf - west	Thick black oil stretching from 4323.3N 6351W to 4355.7N 6355.7W. Oil sampled.
	1115Z	Cape Breton	Oil washed up on the beaches of Big Bras d'Or in quite a considerable amount. Big blobs six inches square and smaller bits. This area had been cleaned previously. There is more oil than there was before.
	1452Z	Cape Breton	More oil coming into Florence.
	1935Z	Scotian Shelf - west	Globules of oil surrounded by a sheen. Area of slick would be approximately 3/4 of a mile by 200 metres. (Tracker report).
April 26	1834Z	Scotian Shelf - west	6 to 10 inch blobs of oil 10 miles south of Barrie Head sighted by Fishermen. Fishermen have not been reporting oil sighted, because they assumed numerous military helicopters working the area were reporting.
	2004Z	Cape Breton	Heavy black oil 3 ft by 10 ft, two in numbers off the yacht club in North Sydney Harbour.
	2030Z	Halifax	Fishermen working Sambro Bank area are encountering oil while fishing.
April 27	1543Z	Eastern Shore	Beaches on Sheep Island, near Whitehead, coated with oil.

Date	Time[1]	General Location[2]	Specific Location, Report Description
April 28	1956Z	Eastern Shore	Oil by the wharf at the Whitehead Island light station, approximately 35x35 ft, and about 8 inches thick. Also a few patches from the boat, approximately 6x8 feet.
April 30	1315Z	Scotian Shelf - west	4411.9N 6416.9W; oil slick approximately 5 to 15 ft wide and 150 to 200 ft long. Appears to be bilge discharge.
	2109Z	Cape Breton	Oil by Irish Brook, Levers Lake, Gabarus. 10 or 11 dead birds in the oil. Oil would be hard to see from the air.
May 1	1314Z	Chedabucto Bay	Beach in cove by Louisdale (Port Hawkesbury) is covered in black oil.
	1358Z	Chedabucto Bay	About 20 dead birds and oil in Richard's Pond, River Bourgeois.
	1755Z	Chedabucto Bay	Black oil slick from eastern limit of Canso zone to Buoy 10 C, Chedabucto Bay. Slick for miles in all directions and heavy blobs 2 feet square along this track.
	1805Z	Eastern Shore	6 miles southeast New Harbour sighted oil-covered dead birds and small patches of oil. 50 miles south of Country Island more small patches of oil , also 20 miles west of Country Island more small patches of oil. The extent of the oil was not determined because of fog.
	2155Z	Halifax	Large amount of oil believed to be Bunker C observed from Pensey Head to Osborn Head on shore. There were patches of oil all along the above area, and about one dozen dead ducks were also seen.
	2356Z	Chedabucto Bay	Quite a bit of oil at Barachois beach next to Pondville, Isle Madame. 20 ft wide by 1/2 mile long. Observed quite a few dead birds.
May 2	1145Z	Eastern Shore	Black oil at Causeway Road, Three-Fathom Harbour, rolled up in seaweed at high tide mark. All along the beach. Pancake to 0.5 size.

Date	Time[1]	General Location[2]	Specific Location, Report Description
May 2 Cont'd.	1351Z	South Shore	Tar-like substance on beach at Bayswater Beach, St. Margaret's Bay. Unknown quantity.
	1400Z	Scotian Shelf - east	4550N 5944W; blobs approximately 6 inches diameter and approximately 20 ft apart for a distance of 1/4 mile on a course of 247 degrees.
	1424Z	Chedabucto Bay	M/V "Gulf Gatineau" reports black oil in large blobs two to four feet in diameter at Buoy 10°C in Chedabucto Bay.
	1458Z	Eastern Shore	Oil at Little Liscombe Road at Redman's Head all along the beach and in the water.
	1543Z	Chedabucto Bay	Blobs of oil approximately 1 by 1 ft over an area two miles long by 1/2 mile wide, and 1 1/2 miles off Fox Island.
	1555Z	Scotian Shelf	4547.5N 5950W; blobs approximately 6 in diameter and approximately 20 ft apart for a distance of 1/4 mile on a course of 260 degrees.
	1648Z	Eastern Shore	Patch of Bunker C oil approximately 30 ft in diameter and 4 in thick in water east side of Whitehead Island. Also quite a bit of oil on the beach and in the water in coves on east side. Also small globs all over the area.
	1658Z	Eastern Shore	Oil in Fisherman Harbour, west of Liscombe, 6 mi south of Port Bickerton and into Fisherman's Harbour. Whole area covered with scattered small patches.
	1730Z	South Shore	Oil on Blanford Peninsula beach and in the seaweed. Oil arrived today with high tide.
	1813Z	Scotian Shelf - west	Oil sheen on the water, but no thick oil. Extent not known, but sheen was visible through fog breaks up to 20 mi away from bow position. (Tracker report).

Date	Time[1]	General Location[2]	Specific Location, Report Description
May 3	0450Z	Chedabucto Bay	Two islands due south of Pt. Michaud beach have oil-covered beaches and lots of dead birds.
	1334Z		Bunker C oil on shore near Cape Auget lighthouse (off Arichat), 6 or 7 dead birds.
	1525Z	South Shore	2 to 3 ft strips of heavy Bunker C oil along Westhaver beach (Mahone Bay) for approximately 1/4 mile.
	1747Z	Cape Breton	Small quantities of oil, Cape North.
	2300Z	Eastern Shore	Three blobs of heavy black oil about 3 ft in diameter within a distance 1/2 mi along Clam Harbour beach.
May 5	-	South Shore	Blobs of oil 6 in to 10 in in diameter, over a distance of 2 mi. 20 to 30 such blobs and numerous smaller blobs, moving in direction of Tancook and LaHave Islands.
	1630Z	South Shore	A few blobs on beach, Martins Point.
	1742Z	South Shore	Oil on beach and in seaweed, 100 yd long and 200 ft wide in Clam Pond, Southwest Cove area of St. Margaret's Bay. Later reports indicate light blobs 4 to 5 in in diameter.
May 6	0005Z	Halifax	Oil in patches and mixed with seaweed near Cow Bay. Largest patches 1 1/2 ft diameter, many smaller patches along with some dead birds at high water mark on beach, 1 1/4 miles.
	1345Z	Halifax	Oil blobs and dead birds on Silver Sands beach, Cow Bay.
	1427Z	Halifax	Oil blobs, some as large as 1 1/2 ft diameter, and dead birds on beaches around Hartlin Point golf course.
	1742Z	Halifax	Heavy, thick oil washed up on beach at Purcell's Cove at the head of the Northwest Arm, approximately 600 ft long and 2 ft wide. Heat of the sun is making the oil run.

Date	Time[1]	General Location[2]	Specific Location, Report Description
May 6 Cont'd.	2022Z	South Shore	Black sticky globs of oil washed up on the shoreline around second Peninsula, Lunenburg Co. The shoreline involved covers about 3 mi, but there is not a great amount of oil.
May 7	1203Z	Halifax	A fair amount of small globules of oil, high on beach, perhaps 1 1/2 to 2 miles long near Rainbow Haven Camp, Cole Harbour dyke.
	1319Z	South Shore	Oil blobs on Big Tancook, Little Tancook and 2nd Peninsula. Some oil, no great extent, also reported on East Ironbound Island.
May 8	1244Z	Halifax	Oil in NW Arm, south side of Dingle Tower. Oil mixed with seaweed around the launching ramp.
	1552Z	Halifax	Small blobs 6 in in diameter on beach at Portugese Cove, Ketch Harbour. Some melting of oil.
	1655Z	Scotian Shelf - west	A heavy slick. Oil is quite thick and a real dark brown. Some has broken up and is a reddish brown. Position 16 mi south of Shelburne Light, bearings 1204 1H2, 1032 1H3. Slick is 4 to 5 mi or possibly longer, and approximately 1 mi side in an east-west direction, and appears to be drifting west.
	1747Z	Eastern Shore	Pollution report from Three Fathom Harbour. Oil on the west side of the harbour.
	1835Z	South Shore	Oil at Herring Cove, Aspotogan Peninsula.
	2244Z	Scotian Shelf - west	(CCGS Daring investigation of 1655Z oil report.) Slick runs in northeast and southeast 8 mi long and from 1 to 3 cables in width from position 4323.5N 6502.5W to 4328.5N 6452W. Color would indicate a mixture of diesel lube oil and detergents. Along eastern edge of slick strips and patches of rusty color droplets 3 to 4 ft in width and up to 24 ft in length. Whole area of slick is very dissipated and broken up. Slick drifting 180 degrees. True at 1.25 knots per hr, spreading out and breaking up rapidly.

Date	Time[1]	General Location[2]	Specific Location, Report Description
May 8 Cont'd.	2332Z	Scotian Shelf - west	(2nd Followup report, viz. 08 2244Z) Oil slick sighted running between the 4324N 6505W and 4327N 6445W and 4335N 6432W. Between the first two coordinates the oil was sighted as being heavy and the width of the slick was estimated to be between 1/2 mi and 1/4 mi. Between the second and third coordinates the slick became lighter, and, if anything, a little wider.
May 9	1205Z	Halifax	Oil washed up on Point Pleasant Park beach south of the monument. There was quite a bit.
	1422Z	South Shore	Oil on the shoreline at Westhavers beach, south of Mahone Bay. Area was cleaned and was reoiled.
	1425Z	Scotian Shelf - west	Northeast position of oil slick 4331.7N 6450.4W, bearing 230 degrees true to 4317.7N 6506.9W. Fifteen nautical miles in length. North part appears scattered and south part heavy oil. (Tracker report).
	1541Z	Scotian Shelf - east	4548.5N 5947.9W; a few small balls of oil sighted, but nothing to be concerned about.
	1720Z	Cape Breton	Oil slick off Bird Island to Point Aconi.
	1744Z	Cape Breton	Light oil in long strips north of Bird Island, not Bunker C. Looks like someone pumped bilges (Helicopter overflight report for 1720Z report).
	1747Z	Scotian Shelf - west	Eastern end 4324N 6502W. This was a large patch 4 to 5 mi in diameter with large patches of moderate oil. Then a narrow strip in the position to 4318N 6507W, and extending further in a SSW direction. Oil in this strip was moderate to heavy. (Follow up report).
	2354Z	Halifax	Oil washing ashore in patches Portuguese Cove, just down from Duncan Cove. Came in on last couple of tides. About two miles in length in patches. Couple of dead birds sighted.

Date	Time[1]	Location[2]	Specific Location, Report Description
May 10	0300Z	Scotian Shelf - west	Position 4320.0N 6503.0W. Small strings and patches of light oil encountered in vicinity of reported slick.
	1142Z	South Shore	Westhavers Beach cleaned, and now more oil. Fair amount of oil on the causeway to the peninsula at Chester. From Millcove to Aspotogan, near Beckmanns Cove. Loaded with oil. Bayswater beach has oil. Fair amount on west Ironbound Island, and on the Tancook Islands.
	1230Z	Chedabucto Bay	Large patches of light oil scattered over complete area. Sitting in large patches around gypsum dock, Nova Scotia Forest Industries and Nova Scotia Power Plant, also Government wharf in Port Hawkesbury.
	1515Z	Scotian Shelf - west	From position 4314.6N 6503W to position 4318N 6502W encounter strings and patches. Very dispersed and broken up. Oil light. At times difficult to follow. No traces of heavy oil sighted. Four miles in length, varying in width from 1/2 to 3 cables. From position 4324N 6448W to position 4321.5N 6445.5W. Also strings and patches. Very light, broken up and very difficult to follow. No heavy oil sighted. 3.2 miles in length and varying in width from 1 to 6 cables. Very scattered. (CCGS Daring Shelburn follow up).
	1652Z	-	Tilly Point, NW Cove; oil all along the shore, dispersed. The size of small coins.
May 15	1538Z	Cape Breton - Sydney	Re-oiling at Sydney Mines. Oil fairly thick patches approximately 1 sq ft. Oil under sand, in blobs. Some oil dried on rocks from previous spills, and fresh oil just can in with the tide. (Cleanup crews left bags behind at Florence, and oil leak out.)
May 16	1132Z	South Shore	Port Bickerton oiling report.
	1238Z	Scotian Shelf - east	4514N 5926W; oil spotted, heavy chunks covering an area approximately 1/2 mile.

Date	Time[1]	General Location[2]	Specific Location, Report Description
May 16 Cont'd.	1455Z	Scotian Shelf - east	CCGS Daring encountered oil in position 4427.7N 5919.5W and continuously along creeping line ahead. Search pattern 1 nm east side 085° true track to present position 4428.2N 5914.5W and still encountering. Stopped in position 4426.1N 5915.5W and obtained four samples oil in globules and flat to oblong shape, varying in size from 1 in globules to 8 in flat pieces, brownish black in color with tar-like feel in appearance. Unable to estimate area due to suspected Bunker C being below surface and only appearing in bow wash and wake doing full speed.
	1925Z	Scotian Shelf - east	CCGS Daring - continued - Proceeding from 4428.0N 5858.9W. At position 4429.8N 5859.1W oil encountered occasionally in groups of 1 to 12 flat plates 8 to 12 in across, and turning up in ship's wake. At 4423.2N 5900.4W oil encountered less frequently.
	2013Z	Cape Breton	Gabarus Bay. Small amount of oil (spotty) on the beach.
	2130Z	Scotian Shelf - east	CCGS Daring. Completed expanding sq search, 5 mi radius, out from 4428N 5858.9W. Occasional sightings of golf ball to grapefruit sized particles since 1900Z. Suggest the substance is well below the surface and due to shallow draft of the vessel the substance appears infrequently. It has been noted that when full astern more of the substance comes to the surface.
	2300Z	Scotian Shelf - east	CCGS Daring. Position 4424N 5905.5W. Retrieved large circular piece of suspected Bunker C, approximately 24 in in diameter, from water. Dark brown in color, pliable with tarlike appearance.
May 17	2000Z	Cape Breton	Main-à-Dieu harbour. Oil in rock and gravel, 2 to 6 in thick, approximately 1 mi in length.
May 18			Oiling report of oiled fish catch at Middle Bank (F/V Cape Rouge).
	0900Z	Scotian Shelf - east	Lady Hammond 4518.08N 5959.23W. Small amounts of small particles (of oil) were observed.

Date	Time[1]	General Location[2]	Specific Location, Report Description
May 18 Cont'd.	1030Z	Scotian Shelf - east	Lady Hammond 4509.43N 5951.83W. Large lumps of oil were located, some were 4 to 5 in in diameter.
	1125Z	Scotian Shelf - east	Report from F/V Cape Pictou. Fishing vessel towed through oil with fishing net, and has oil on nets. Sample kept. Position of oil, decca chain 6B 1520 on red-green G 41.50 Eastern end of Gully Cove, east of Sable Island. Depth of 70 fathoms. Also seen a lot of patches of oil in semi-solid state approximately sizes from 12 in to 24 in.
	1725Z	Cape Breton	Bonneville beach is thick with oil.
	1835Z	Cape Breton	River Bourgeois. Oil on Church point and on Richaus Pond. Many oiled seagulls.
	1900Z	Scotian Shelf - east	CCGS Daring. Position 4455.4N 6006.4W sighting oil in 2 in to 2 ft pieces, at intervals 1/2 to 1 1/2 mi.
	2230Z	Scotian Shelf	Fisherman report, fishing off Sea Island on the western side of the Gully. He found Bunker 1 1/2 ft thick and was in it for 20 mi. Samples were taken.
May 19	0100Z	Scotian Shelf - east	Patches of oil sighted in approximate position 4525N 6018W for 1/4 mile in fog.
	18747Z	South Shore	Small amount of oil by Liverpool wharf and some oil scattered on beach, mixed with gravel.
	1830Z	Eastern Shore	Oil on Harbour Island off Drum Head. Had been there a while. Deposited down between high-tide line rocks. Also reports of oil on beach at Sea Breeze Cape Ground on Fox Island.
	1841Z	Eastern Shore	Trawler spotted oil 11 mi south-southeast of Country Island. Pieces of oil like dinner plates. At times they saw five of six at a time in the fog. Oil melted when some of the pieces were taken aboard.

Date	Time[1]	General Location[2]	Specific Location, Report Description
May 19 Cont'd.	1850Z	Scotian Shelf - east	Lady Hammond entered thin slick 1/2 mi wide, length unknown due to fog. Contained scattered large particles from 1/2" to 8" diameter at position 4457N 5914W, Banquereau Bank.
May 20	1204Z	Cape Breton	Large oil slick on the entrance side of Seal Island bridge.
	1727Z	Chedabucto Bay	Beach badly fouled with oil, near RMCP detachment, W. Arichat.
	2022Z	Scotian Shelf - west	Large amount of oil sighted in position 4449.5N 6102W. Oil was in globs about 2 to 3 inches, with some smaller amounts.
May 21	1107Z	Scotian Shelf - east	Great deal of oil 4543N 5902W.
	1238Z	Chedabucto Bay	Continuous spots of oil on Petit-de-Grat beach. Band 15 in wide at high tide mark.
	1413Z	Scotian Shelf - east	Lady Hammond in oil patch 2 mi by 2 mi at 4511.24N 5942W. Thin film, mat black in color with few lumps. Bulk of the oil out there appears to be concentrated on the west side of Misaine Bank.
	1728Z	South Shore	6 or 7 blobs of oil on beach Corkums Island, Lunenburg Co.
May 22	1310Z	Eastern Shore	Oil 15 mi SE Country Island.
	2101Z	South Shore	Oiling report, Liverpool.
	2348Z	Cape Breton	Oil sighted at Mira Bay, northwestern bank between Main-à-Dieu and Bateston. Also on Buckley's beach near Bateston. Heavy in spots, light in others. Getting runny due to heat. Oil is spotted along coast. One may not see any for a couple of hundred feet, then find some more. Some patches 10 to 15 ft, others quite small.
May 23	1105Z	South Shore	Re-oiling report, Blandford.
		Eastern Shore	Boats covered with oil. Area of Long Island, Jeddore, Little Harbour (Clam Bay area). Also blobs of oil on the water.

Date	Time[1]	General Location[2]	Specific Location, Report Description
May 23 Cont'd.	1525Z	Eastern Shore	Oil on outside of Sober Island, towards Marquis Point on south side of beach. Also on Heads Island off Quoddy Head. Oiled ducks, seaweed. Small amount of oil throughout islands in the surrounding area.
	2025	Eastern Shore	Eastern end of Martinique Beach is heavily oiled. Large numbers of dinner plate and smaller blobs of oil. Over 25 birds of various types covered with oil. Apparently recently dead as fresh blood was evident. Fresh oil was on surface of water washing in with tide. Oil has washed up on beach of Graham Head.
May 24	1908Z	Cape Breton	Small amounts of oil in pathes in water off Bird Island, straight out from St. Anne's Bay.
May 25	1839Z	Eastern Shore	Oil in the water seen Wednesday and Thursday at Pope's Harbour and Tangier. Oiled ducks reported.
	2018Z	Eastern Shore	Continuous influx of oil onto Martinique Beach. Heavy oiling over 2 mi distance.
	-	South Shore	Bayswater beach re-oiled, with big blobs coming in.
	2044Z	Eastern Shore	Oil slick at Little Harbour off Long Island beach, Clam Bay area. Fishermen report going through it and getting oil on their boats. Also dead birds on shore with oil on them.
May 26	1238Z	Eastern Shore	Oil on beach at end of East Chezzetcook road, in seaweed in globs.
	1540Z	Eastern Shore	Patches of oil on beach at Three Fathom Harbour.
	1540Z	Eastern Shore	Oil on beach east side Lawrencetown Beach.
	1857Z	Scotian Shelf - east	FV "Rodney and Sisters" reports that it is in oil with lumps in it all morning, position 7 mi SSE CA buoy.

Date	Time[1]	General Location[2]	Specific Location, Report Description
May 26 cont'd	1928Z	Halifax	Globs of crude on rocks, silver dollar size and larger, at Portuguese Cove. Oil is mostly down between the rocks. It is newly deposited oil.
	2105Z	South Shore	Oil on Kingsburn beach in Lunenburg City.
May 27	1642Z	South Shore	Oil and dead birds on Hartling Beach (Hartling Bay, Kingsburg).
	1819Z	South Shore	Fair amount of oil coming ashore on Kingsburg beach. Very black, sticky and thick. Blobs 1" to 1' in diameter along high tide line.
	1940Z	South Shore	Oil on Kingsburg beach.
	1953Z	Eastern Shore	Beach at Ostrea Lake (near Pleasant Point, Musquodoboit Harbour) is covered with oil. (This later confirmed, and found to be a small amount of oil, not enough for a separate cleanup crew).
	2233Z	Eastern Shore	6 dead birds on Conrad's Beach.
May 28	1150Z	South Shore	Black tar-like blobs of oil 6" to 7" diameter along 500 to 600 ft of shoreline in Rose Bay, Lunenburg Co.
	1241Z	South Shore	Blobs of oil along high tide and in the seaweed at Peggy's Cove. Duncan Cove is also oiled.
	1348Z	Eastern Shore	Misner Lake East (Chezzetcook) has some oil in it. There is also quite a bit at the head of the lake.
	1421Z	Cape Breton	Petit Anse is re-oiled. Oil in fish traps off Ox Island.
	1452Z	Scotian Shelf - east	FV "Rowan and Sisters" was in a large oil patch for 5 days in position 4426N 5827W, Banquereau Bank.
	1558Z	Eastern Shore	Oil and dead birds, thick and in blobs near Cow Bay. This was cleaned up before, but more can be seen on the water.

Date	Time[1]	General Location[2]	Specific Location, Report Description
May 28 Cont'd.	1723Z	South Shore	Lots more oil drifted in on beach, Fox Island, Guysborough Co.
	2327Z	Eastern Shore	Oil and dead birds, thick and in blobs near Cow Bay. This was cleaned up before, but more can be seen on the water.
	2036Z	Eastern Shore	8 to 10 miles west of Tuffin Island, off Ecum Secum, sighted an area in size of acre, of broken pieces oil. (Some 1/2 gallon size blobs.)
	2327Z	Eastern Shore	Small lumps of congealed black oil, largest 4" in diameter, in the area of CB buoy, Canso Strait. Area extends 1/2 mile along ship track.
	1829Z	Sable Island	Oiling tapering off. Island surrounded by oil blobs. Seals on the island reportedly spotted with oil.
	1842Z	Cape Breton	Small smounts of oil in following areas: Kelp cove, Baleine, Main-à-Dieu, Cannes, Shoumou(?).
May 29	1410Z	South Shore	Bayswater Beach, Blandford Peninsula, being polluted by debris covered with oil being washed ashore.
	1723Z	Halifax	Oiling in Purcell's Cove, oil ranging in size from a 50-cent piece to very large blobs. Thought to be freshly arriving oil.
	2214Z	South Shore	Bunker C from coin size to 8 inches in diameter covering beaches for about 2 miles in location Ovens Park area, 12 miles SE of Lunenburg.
	2320Z	Cape Breton	Oil in kelp and on beaches along 2 miles of beaches at Little Pond. This oiling cannot be seen from helicopter, reportedly.
May 30	0101Z	South Shore	Bayswater beach and Westhaver Beach are heavily re-oiled.
	-	Eastern Shore	Cow Bay has some oil in seeweed.

Date	Time[1]	General Location[2]	Specific Location, Report Description
May 30 Cont'd.	1222Z	Eastern Shore	Globs of oil seen while fishing east of Halifax along shore. Some size of saucers, some barrel size.
		Eastern Shore	Blobs of oil 3 inches to 1 ft in diameter at Three Fathom Harbour. Oil is in seaweed and on rocks, with dead birds and fish in the area.
	-	Cape Breton	Large amount of oil at Point Michaud and Lower L'Ardoise on sand and in kelp.
	-	Halifax	Big oil blobs on shore of North West Arm across from Point Pleasant Park.
	2355Z	South Shore	Oil on shoreline and about 200 yards up the Gold River, Gold River, Chester Co. The oil looks light and has rainbow colors.
	2055Z	Cape Breton	Oil on White Point and Black Rock area, is in seaweed, on birds and over rocks.
	1935Z	Eastern Shore	Oil off Hartlin Point, about 1/4 mile of beach. Oil mixed with seaweed. Estimated at about 25 to 30 bags. Shoreline consists of sand, gravel and larger rocks.
	1625ADT	Cape Breton	Oil reported all along north side of Scatarie Island. Small amount of oil sighted at eastern light area.
	-	Scotian Shelf - east	Oil at position 4602.12N 5942.24W, extending for 1 mile and approximately 60 yards offshore. Oil varying in size from 2 inches square to 1 foot square.
	1650ADT	Scotian Shelf - east	30 to 50 pieces of oil 3 inches in diameter 2 miles south of Louisbourg light.
	1851Z	Eastern Shore	Oiling of 1/2 mile of shoreline near Guysborough Harbour. Suspected Bunker C. Scattered blobs 6 inches to 2 feet in diameter.

Date	Time[1]	General Location[2]	Specific Location, Report Description
May 31	1530Z	Halifax	Continuous blobs of oil from Inner Sambro Island to Bear Cove buoy.
	1609Z	South Shore	Oil about 2 miles off Cape Mocodome, east of Port Bickerton. Looked like quite a bit.
	1157Z	Halifax	Salmon gear covered with oil for 2 or 3 days in Portuguese Cove. 4 or 5 dead birds reported, dead approximately 2 to 3 weeks.
	1251Z	Halifax	Oiled mackerel nets, Purcell's Cove and Herring Cove.
	1417Z	South Shore	Oiled debris coming ashore on surface of water on Bayswater beach. No oil on the beach at this time.

APPENDIX IV

LEGENDS TO SLIDE PACKAGE

1. CSS Hudson in ice off southeast Cape Breton Island, March 1979. Oil contained within ice is seen in the right foreground.

2. Heavy fog hampered oil surveys during the first days after the Kurdistan breakup, and often prevented detailed observation and location of oil-in-ice distribution.

3. Oil slicks entrained in ice off southeast Cape Breton Island, March 24, 1979.

4. Oiled ice in major oil streak observed in ice southeast of Cape Breton Island, March 24 to 25, 1979.

5. Water-column sampling fom CSS Hudson lifeboat.

6. Steel-mesh water surface sampler developed for collecting particulate and micro-particulate oil particles from sea surface.

7. Launching surface neuston tow net from CSS Hudson near ice off Cape Breton Island, March 24, 1979.

8. Detail of oil lumps entrapped within ice floe off southeast Cape Breton Island, March 24, 1979. Ship's pike-poles in foreground provide scale for comparison.

9. Oil-blob on ice-block offshore from Cape Breton Island, March 24, 1979.

10. Oiling of brash ice offshore from Cape Breton Island, March 24, 1979.

11 and 12. Particulate oil staining of ice taken from surface waters offshore from Cape Breton Island, March 24, 1979.

13. Detail of particulate oil staining ice, offshore from Cape Breton Island, March 24, 979.

14. Sediment staining of surface ice, offshore from Cape Breton Island, March 24, 1979. Sediment-stained ice often appeared as oil-stained ice without closer examination.

15. Ice stained by algal inclusions, Cape Breton Island, March 24, 1979.

16. Subsurface melt-holes in ice floe often were initially mistaken for subsurfae oil or tar.

17. Ice-packed Lennox Passage, Chedabucto Bay, March 28 to 29, 1979.

18 to 20. Sediment streaks in shore-bound ice, Chedabucto Bay, March 28 to 29, 1979. Such sediment streaks, originating from Prince Edward Island waters, were easily mistaken for oil staining at first glance.

21 to 22. Oil-stained shore-ice, St. Esprit Island, March 28 to 29, 1979.

23. Oiled pitted surface of shore-ice, St. Esprit Island, March 28 to 29, 1979. Most of the ice surface was pocked and cratered in this manner.

24. Detail of eroded shore-ice surface, showing melt-hole caused by oil-droplet.

25. Fresh oil stranding on gravel-pebble beach of Phillips Harbour, May 4, 1979.

26. Oiled pebbles along high-tide line, South Sydney Bar, May 2, 1979.

27. Oiled boulder near coal outcropping (left foreground) on Big Glace Bay lake beach, May 29, 1979.

28. Oil-pebble accumulation on rock outcropping, Big Glace Bay lake beach, May 29, 1979.,

29. Uncleaned oiled north shore of Big Glace Bay lake, Cape Breton Island. Note oil in the intertidal zone adjacent to the vegetated lake edge, May 3, 1979.

30. Oiled debris in water's edge, north shore of Big Glace Bay lake, May 3, 1979.

31 and 32. Oiled marsh vegetation, Framboise Cove, Cape Breton Island, May 4, 1979.

33. Sunken oil in river of Glace Bay lake, Cape Breton Island, May 3, 1979.

34. Clean-up operation of Point Michaud beach, May 4, 1979.

35. Clean-up of stranded oil along Framboise beach, May 4, 1979.